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IEP NEWSLETTER

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A Management Perspective

Zach Hymanson (DWR), zachary@water.ca.gov

***Exopalaemon modestus* caught in a beach seine haul of Yolo Bypass pond in December 2001. This haul, pictured with a threadfin shad for size reference, yielded 1,196 shrimp. Photo: Gavin O'Leary, DWR.**

The IEP continues to detect the occurrence and establishment of introduced aquatic organisms. This issue of the *IEP Newsletter* presents information on a relative new-comer, the freshwater shrimp *Exopalaemon modestus* (see photo above and articles by Hieb, page 4, and Zeug and others, page 13) and another occurrence of a previously identified zooplankton, *Daphnia lumholtzi* (see article by Orsi, page 15). First detection of both organisms occurred relatively recently, so we are still learning about the biology and potential ecological effects of these organisms.

In related news, Feyrer (page 9) presents a summary of a recent IEP-sponsored meeting focusing on resident fish communities in the Delta and its tributaries. A major finding of this meeting was that non-native fishes outnumber native species in many locations throughout the Central Valley. Meanwhile, recent work by Rudnick and Resh (page 19) found the introduced Chinese mitten crab is directly affecting the economic viability of some commercial fisheries in the estuary. This information, as well as the work by many other scientists, show introduced species are a substantial—and in many cases—dominant component of the aquatic flora and fauna of the estuary. The never-ending detection of new introductions suggests this form of biological pollution continues to represent a real danger to native species within the estuary and, in some cases, the economic dependence we have on them. It is increasingly important for managers and scientists to consider the influence of introduced species as we develop plans and expectations for habitat restoration.

Managers should also peruse the "On the Horizon" section of the *Newsletter* for information on new studies and upcoming events. The IEP and CALFED have some major activities in the works!

We invite managers to submit articles and information of interest to the *IEP Newsletter*. The *IEP Newsletter* provides and excellent opportunity for managers to communicate directly with many of the scientists, stakeholders, and other people interested in the San Francisco Estuary and its watershed. Send your written submittals to Lauren Buffaloe (buffaloe@water.ca.gov) at any time.

Quarterly Highlights

Dissolved Oxygen Levels in the Stockton Ship Channel

Casey Ralston and Stephen P. Hayes, DWR
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Dissolved oxygen concentrations in the Stockton Ship Channel are closely monitored during the late summer and early fall of each year to detect any development of a dissolved oxygen sag, an area where dissolved oxygen levels are 5.0 mg/L or less. The decrease in dissolved oxygen in the channel is apparently due to low San Joaquin River inflows, warm water temperatures, high biochemical oxygen demand (BOD), reduced tidal circulation, and intermittent reverse flow conditions in the San Joaquin River past Stockton. Low dissolved oxygen levels can cause physiological stress to fish and inhibit upstream migration of salmon.

Monitoring of dissolved oxygen levels in the channel was conducted seven times between August 1 and December 5, 2001, from the vessel *San Carlos*. During each of the monitoring runs, 14 sites were sampled from Prisoners Point in the central Delta to the Stockton Turning Basin. Dissolved oxygen and water temperature data were collected for each site at the top and bottom of the water column during ebb slack tide using traditional discrete (Winkler titration) and continuous monitoring (Seabird 9/11 multiparameter sensor) instrumentation. Monitoring by vessel is supplemented by an automated multiparameter water quality recording station near Burns Cutoff at the western end of Rough and Ready Island. This site captures diel variation in dissolved oxygen levels and indicated that throughout the fall monitoring period early morning dissolved oxygen levels were often lower than values recorded later in the day.

As in previous years, dissolved oxygen levels in the western channel from Prisoners Point to Disappointment Slough were relatively high and stable throughout the monitoring season, ranging from 7.0 to 9.9 mg/L. Dissolved oxygen concentrations within the central channel from Columbia Cut to Fourteenmile Slough were more variable (3.9 to 9.9 mg/L). Within this region, surface and bottom levels dropped below 5.0 mg/L in August, September, and October. In the eastern portion of the channel (from Buckley Cove to the eastern end of Rough and Ready Island), a dissolved oxygen sag was more persistent at the bottom of the channel. Dissolved oxygen levels were stratified there and the lowest value (3.72 mg/L) was recorded at Light 40 on August 1, when water temperatures were warm (22.5 to 25.1 ºC) and San Joaquin River inflows past Vernalis were low (about 1,400 cfs [39.6 m^3/s]). Because of the low dissolved oxygen levels the head of Old River barrier was put into place on October 7. The barrier remained in place until November 27.

By November 2, 2001, dissolved oxygen levels throughout the channel had recovered to 6.0 mg/L or greater. Sampling on December 5 indicated that dissolved oxygen concentrations continued to improve with all levels greater than 7.0 mg/L. Significantly cooler water temperatures (10.6 to 11.7 °C) and maintenance of adequate San Joaquin River inflows (average daily inflows past Vernalis exceeded 2,000 cfs [56.6 m^3/s]) appear to have contributed to sustaining improved dissolved oxygen conditions in the channel.

For a complete summary of dissolved oxygen levels in the Stockton Ship Channel for 2000, see article by Ralston and Hayes on page 26.

Identifying the Carbon Sources and Trophic Structure of Fishes in Tidal Wetlands of the Sacramento-San Joaquin Delta

Lenny Grimaldo (DWR), lgrimald@water.ca.gov

The purpose of this study is to elucidate food web pathways of fishes in the Sacramento-San Joaquin Delta using stable isotope analysis (see Stewart 2001). Fish, invertebrates, and primary producer samples were collected from Venice Cut, Mildred Island, and Sherman Island between June 1999 and July 2001. To date, over 1,200 biological samples have been prepared for analysis. Approximately 200 remaining samples should be processed by the end of January 2002. Prepared samples are sent to the isotope lab at U.C. Davis for determination of carbon (^{13}C:^{12}C) and nitrogen (^{15}N:^{14}N) ratios.

Preliminary results were presented at the IEP Annual Workshop at Asilomar Conference Center in Pacific Grove, California.

Reference

Stewart R. 2001. Applications of stable isotope research in understanding complex ecological processes in the San Francisco Estuary. IEP Newsletter 14(4):27–32.

San Francisco Bay Fisheries Monitoring

Kathy Hieb (DFG), khieb@delta.dfg.ca.gov

The San Francisco Bay Study continued to sample fishes and macroinvertebrates monthly from October to December 2001. Notable collections included a substantial number of Pacific sardine: most fish were ages one, two, and three—all year classes produced after the last El Niño event (1998). Most likely these fish were spawned in the Southern California Bight and migrated north, since ocean temperatures have been too cool for successful local reproduction in recent years.

A recently detected introduced shrimp was identified as *Exopalaemon modestus* (Heller 1862) by Greg Jensen of University of Washington and confirmed by Cai Yixiong of the National University of Singapore. This is a freshwater species and a member of the family Palaemonidae. Its native range includes East Siberia, Korea, mainland China, and Taiwan. It was first collected in the Columbia River in 1995, so it is not known if our population originated from Asia or the Columbia River. In the San Francisco Estuary it appears to be most common upstream of the confluence of the Sacramento and San Joaquin rivers. The largest single collection to date was from a fall midwater trawl tow near Stockton in fall 2001. They have been reported as far upstream as the upper Yolo Bypass[1] in the Sacramento River watershed and Mossdale on the San Joaquin River. Not much is known about the life history in its native range, as *E. modestus* are not intensively harvested. Specimens have been saved or reported by IEP studies that typically do not report shrimp; we plan to work cooperatively to develop some key life history information for this estuary, such as relative abundance, distribution, location and timing of reproduction, and rearing areas.

1. See article by Zeug and others on page 13 for more information.

Based on otter trawl catches from October to December 2001, the adult Chinese mitten crab (*Eriocheir sinensis*) population is larger than in 1999 and 2000. However, catches in fall 2001 were far lower than in 1998, the year with the highest adult mitten crab abundance to date.

Catches of the introduced shokihaze goby, *Tridentiger barbatus*, continued to increase in 2001. The Bay Study collected 559 shokihaze gobies in 2001, up from 121 in 2000, 11 in 1999, 16 in 1998, and 4 in 1997. We collected only 60 shimofuri gobies (*T. bifasciatus*), and 30 chameleon gobies (*T. trigonocephalus*) during 2001. We collected shokihaze gobies from San Pablo Bay to Rio Vista on the Sacramento River and San Andreas Shoal on the San Joaquin River. In 2001 the majority of larger shokihaze gobies (>60 mm total length, TL) continued to be collected in Suisun Bay, while most of the smaller fish (<25 mm TL) were collected in the lower Sacramento River near Sherman Island.

Juvenile Fish Monitoring

Rick Burmester (USFWS)

The USFWS continued monitoring of juvenile salmon and resident during the fall and early winter of 2001–2002. We base juvenile chinook race designations on the Greene modification of the Fisher size criteria.

Winter-run sized juvenile chinook were first collected on October 15 in the Sacramento area beach seine. Winter run were first captured at Chipps Island on December 3. These fish continue to be collected throughout the Sacramento River and Chipps Island sampling area.

Late fall-run sized chinook were first observed entering the Delta on November 16 at Verona, then at Chipps Island on November 26. Only ten late fall run have been collected in the lower Sacramento River beach seine, 43 in the Sacramento area beach seines and trawl, 1 in the interior Delta and 35 at Chipps Island.

Spring-run sized chinook were detected from Colusa State Park downstream into the Sacramento area on November 26. These fish have not been detected at Chipps Island and only two have been captured in the interior Delta. Totals to date include 151 for the lower Sacramento River beach seine and 150 in the Sacramento area beach seines and trawl.

Fall-run sized chinook were first collected in the Sacramento area on December 4 and at Chipps Island beginning December 11. While sampling in the Sacramento River to Chipps Island area continues to pick up these fish, only one has been taken within the interior Delta and one in the Mossdale trawl through January. On January 16, one fall-run fry (37 mm) was captured at Point Pinole, San Pablo Bay, probably a result of the high flows following the January storms. A total of 1,996 fall-run salmon has been collected in the lower Sacramento River beach seine; 1,531 in the Sacramento area beach seines and trawl; and 68 in the Delta area beach seines and Chipps Island trawl.

Wild steelhead (no adipose fin clip) catches have been low—one was seen in the Sacramento trawl on January 15 (258 mm). One adult was captured in the beach seine at Garcia Bend on December 5.

Other fish catches of interest include five shokihaze goby and six white sturgeon (413 to 850 mm) at Chipps Island. Between 1988 and 2001, only 15 longfin smelt had been detected by trawling at Sacramento, but on January 2, 2002, eight longfin smelt (109 to 126 mm) were collected in the Sacramento Kodiak trawl. One wakasagi was caught at Colusa State Park on January 3, the farthest upstream Sacramento River capture for this fish species.

Sampling on the San Joaquin River expanded on December 6 when increased flow allowed access to upstream beach seine sites accessible only by boat. To date no chinook have been captured from any of these beach seine sites. With increased flows, the Mossdale Kodiak trawl began again on January 7. Only one juvenile chinook has been caught so far in this trawl.

For more information about this monitoring program, see the Delta Juvenile Fish Monitoring Program at http://www.delta.dfg.ca.gov/usfws/.

Fall Midwater Trawl Survey

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The California Department of Fish and Game successfully completed the 2001 Fall Midwater Trawl Survey (FMWT) that targets age-0 striped bass. Monthly surveys were conducted from September through December, sampling from San Pablo Bay east to Stockton on the San Joaquin River and Hood on the Sacramento River. Data are still undergoing error checking, so the results presented here are preliminary.

The 2001 abundance index for striped bass of 723 is nearly doubled from 2000 index of 390. Five hundred and forty-three age-0 striped bass were caught during the sampling season; the majority was collected in Suisun Bay. The increased FMWT abundance index was not consistent with the 2001 Townet Survey (TNS) index, which decreased from 5.5 in 2000 to 3.6 in 2001.

The delta smelt abundance index decreased from 756 in 2000 to 603 in 2001. Five hundred and nineteen delta smelt were caught during the FMWT, 409 during October. Delta smelt were concentrated in the lower Sacramento River near Sherman Lake in all months except November when 57% of the delta smelt caught were in Suisun Bay.

The 2001 abundance index for splittail (all ages combined) is 27. Catch during the survey was comprised of 10 age-0 and 14 age-1 and older fish. Seventy-one percent of the splittail were caught in the Suisun Bay area and 50% at a single station in western Montezuma Slough. No splittail were caught in November.

Townet Survey

Marade Bryant (DFG), mbryant@delta.dfg.ca.gov

The 2002 Townet Survey will be conducted as usual in late spring and early summer. Meanwhile, off-season activities have concentrated on automating calculations of the annual striped bass 38.1-mm and delta smelt indices and reviewing and revising the existing sampling protocol.

Automating the calculation of the delta smelt index has been completed, but the Townet Survey staff, with the help of Kris Lightsay from the Department of Water Resources, is in the process of automating the calculation of the striped bass 38.1-mm index. The indices are calculated differently for the two species. The striped bass annual index is calculated by interpolating between the two surveys that bracket a mean size of 38.1-mm FL, whereas the delta smelt index is calculated by averaging the first two survey indices. We hope to have the annual striped bass 38.1-mm index calculation automated by the beginning of the 2002 Townet Survey season.

The protocol was last updated in 1995. The revision includes a history of the survey and procedures to ensure the net is fished in a consistent manner when sampling vessels change.

Sturgeon Tagging

Nina Kogut (DFG), nkogut@delta.dfg.ca.gov

In the fall 2001 *IEP Newsletter*, we reported sturgeon tagging highlights from August 6 to mid-September 2001. Here, I provide an update through October 31, the last day of tagging in 2001.

Sturgeon were caught in San Pablo Bay with a 366-m variable mesh drift trammel net. Reward tags were attached to legal-sized (117 to 183 cm total length, TL) sturgeon. A total of 1,015 legal-sized sturgeon was caught (979 white, 46 green) and most were tagged (911 white, 45 green).

In 2001, under a contract with the University of California, Davis, we tagged a month earlier than in previous years in attempt to collect more green sturgeon. In past tagging efforts, green sturgeon catches declined considerably during September and October. If normal fall tagging was sampling the end of a summer migration into the estuary or an emigration after spawning upstream, more green sturgeon might be caught in August. This proved to be the case, as half of the total catch of legal-sized green sturgeon were caught in August (23 of 46), as well as 61% (99 of 161) of the sublegal total.

Consistent with the greater catches of green sturgeon in August, the ratio of green to white legal-sized sturgeon was higher in August (11:100) than in September-October (4:100). The September-October 2001 ratio is the highest on record. Previously it has ranged from 0:100 in 1994 to 3:100 in 1974 and 1990. Sublegal green sturgeon were more common than sublegal white sturgeon in August (99 green to 70 white, approximately 141:100). In September-October 2001, the ratio dropped to 49:100. Sublegal ratios in previous years have ranged from approximately 1:100 in 1993 to 169:100 in 1974.

The multiple-census abundance estimate for white sturgeon >102 cm TL (the size limit before 1990, used here for comparison with estimates before that time) was 120,000 in 2001, lower than in 1997 (141,900) and 1998 (144,400). These estimates are higher than in previous years, which ranged from 11,200 in 1954 to 117,600 in 1984.

Green sturgeon abundance is estimated by multiplying the white sturgeon population estimate by the green sturgeon to white surgeon ratio. The estimate in 2001 was 8,421, the highest on record. Before 2001, green sturgeon abundance estimates ranged from about 200 (1954 and 1974) to 1,900 (1979 and 1967).

Since 1994, we have recorded other species caught during sturgeon tagging. Bat rays (595) were the most common species caught other than sturgeon in September-October 2001, followed by chinook salmon (247), leopard shark (191), and starry flounder (150). Chinook salmon and starry flounders were more commonly caught in 2001 than in previous years. Chinook salmon catch has ranged from 20 in 1997 to 154 in 1998. Starry flounder catch has ranged from 19 in 1994 to 51 in 1998.

Yolo Bypass Floodplain Study

Bill Harrell, bharrell@water.ca.gov; Ted Sommer; Gavin O'Leary; and Steve Zeug (DWR)

The sampling season for the Yolo Bypass Program began this year with the installation of a fyke trap in the perennial Toe Drain channel in late September 2001. We plan to operate the trap through the end of June, but may encounter periods when we have to suspend sampling due to high flows and debris loads. With the completion of our second season of sampling last June (2001), we began data analysis on adult species composition, timing and duration of fish migration into the Yolo Bypass relative to different physical conditions. After further analysis is completed, the results of this study will be compiled into a manuscript and submitted to a peer-reviewed journal for publication.

Native fish caught from October through December 2001 included seven adult chinook salmon (mean FL: 817 mm), eight Sacramento suckers (mean FL: 451 mm), three Sacramento splittail (mean FL: 328 mm), and one Sacramento blackfish (fork length 380 mm). These are similar numbers of native species catches at this point in the season last year. Striped bass numbers, however, are down from 117 at this time last year to 56 this year. Other species include black and white crappie, carp, white catfish, and channel catfish.

This season a second fyke trap was installed about 2.5 kilometers upstream of the first trap. This trap will be used primarily to ensure enough fish are available for a radio telemetry study designed to assess fish movements through the bypass. We are planning to tag and track chinook salmon, white sturgeon, splittail, and striped bass. Zoltan Matica of the DWR-ESO fish facilities section will do tagging and tracking with assistance from our crew. The tagging study began in January 2002.

Similar to previous sampling years, the fish research component of the study will also include the use of a rotary screw trap and a number of beach seine stations. The screw trap was installed near the base of the Yolo Bypass in the Toe Drain in October 2001 and will be operated (beginning in January 1, 2002) five to seven days per week, depending on catch and debris load. Beach seine sampling will be conducted at a number of locations in and around the perimeter of the floodplain on a monthly basis until floodplain inundation. During inundation beach seine stations will be sampled weekly. In addition, we will release a total of 200,000 coded-wire-tagged salmon in groups of 50,000 into both the Yolo Bypass and the Sacramento River during February. These paired releases will provide additional information about floodplain salmon residence time, growth, and survival.

New project components for this year will include contaminant sampling (Kathy Kuivila and Jim Orlando, USGS) and splittail genetics investigations (Bernie May, UCD). These new components are part of a two-year effort funded by the CALFED Science Program.

Yolo Bypass Perennial Pond Study

Fred Feyrer, ffeyrer@water.ca.gov; Ted Sommer; Gavin O'Leary; Steve Zeug; and Bill Harrell (DWR)

During the summer we completed field work for a study on the habitat characteristics and fish communities of perennial floodplain ponds in the Yolo Bypass. Our goal was to determine if whole-pond habitat features could explain fish community structure and to examine the value of such habitats for native fish populations with regard to floodplain restoration projects. We studied seven ponds—three were located in the Yolo Basin Wildlife area and four were located in the northern reach of the bypass near the Fremont Weir. We examined numerous physiochemical habitat features of the ponds and used beach seines, gill nets, and boat electrofishing to sample fishes. Preliminary results suggest all ponds were eutrophic based upon high chlorophyll *a* or dissolved nutrient concentrations and large shallow ponds generally exhibited different physiochemical characteristics compared to small deep ponds. Our fish sampling collected 13,687 fishes represented by 23 species. The ponds were dominated by non-native fishes in both numbers and biomass. The only natives we collected were Sacramento blackfish, Sacramento sucker, and prickly sculpin. These natives comprised <1% of the total number of individuals and <3% of the total biomass. Inland silverside was the most numerous species, while common carp accounted for the most biomass. The numerical and biomass density of fishes was generally greater within the shallower ponds and most of the ponds possessed a greater diversity (H') of small versus large fishes. Multivariate analyses suggest that fish community structure varied among the ponds and was significantly correlated with specific conductance, total dissolved solids, and secchi depth. Interestingly, the new palaemonid shrimp (identified as *Exopalaemon modestus*) has reached extremely high densities in several of the ponds (see article by Zeug and others on page 14). The results of this study have been compiled into a manuscript that will be submitted to a peer-reviewed journal for publication.

Suisun Marsh Salinity Control Gates

Robert Vincik (DFG), rvincik@delta.dfg.ca.gov

The 2001 adult salmon telemetry study at the Suisun Marsh Salinity Control Gates in Montezuma Slough finished November 2. Through the three operational phases of the salinity control gates, 198 adult salmon were tagged and monitored for passage:

- Phase I—Gates held open, flashboards out, boat lock closed (Sept. 24 through Oct. 7).
- Phase II—Gates tidally operated, flashboards in, boat lock open (Oct. 8 through 21).
- Phase III—Gates tidally operated flashboards in, boat lock closed (Oct. 22 through Nov. 2).

In addition to the fixed hydrophone stations at the gates, mobile monitoring by boat was conducted throughout the length of Montezuma Slough. A concurrent study using fixed hydrophone stations and mobile monitoring along the Sacramento and San Joaquin rivers tracked the tagged salmon's upstream migration once past the gates.

A total of 66 adult salmon per operational phase (198 total) was tagged, released downstream, and monitored as they passed the gates. During Phase I, 38 salmon passed the gates with a mean passage time of 15.3 hours. In Phase II, 44 salmon passed the gates with a mean passage time of 25.5 hours and during Phase III 36 salmon passed the gates with a mean passage time of 47.4 hours.

The Montezuma Slough study focused on adult salmon, using the existing boat lock as a means of upstream passage, while the salinity control gates were tidally operated during fall and winter. Preliminary findings show a higher rate of passage during Phase II (boat lock open)—although the rate was not significantly different from the other phases—and a significantly higher passage time during Phase III (boat lock closed).

The adult salmon telemetry study will be repeated in fall 2002 with the operational phases in a different order to confirm the 2001 findings and possibly validate the effectiveness of using the boat lock to facilitate salmon migration through Montezuma Slough.

Adult Fish Tracking in the Delta Cross Channel

Derek Stein (DFG), dstein@delta.dfg.ca.gov

DFG tagged adult chinook salmon with sonic tags as part of a multi-agency effort commencing at the Delta Cross Channel in the fall of 2001. One hundred and thirty-four salmon were tagged on the San Joaquin River at Jersey Point and 198 during a concurrent DFG study at Montezuma Slough (see previous quarterly highlight report). Our objective was to determine the effects of the Delta Cross Channel and the gate operations on migrating adult salmon. We followed salmon movements using fixed-telemetry stations and mobile tracking units. The fixed stations were located throughout the north Delta, Delta Cross Channel, San Joaquin River, and Sacramento River. The movements of all 332 salmon tagged at both locations were evaluated for passage in the cross channel.

Our preliminary data indicate that 84 tagged salmon from both DFG studies were detected at the Hood station on the Sacramento River, seven on the San Joaquin River at Mossdale, and three on the Mokelumne River at Woodbridge Dam. Our fixed stations detected 28 adult salmon in the Delta Cross Channel: 22 of these were tagged on the San Joaquin River at Jersey Point. Apparently these fish were coming from both sides of the cross channel.

We found that sonic-tagged salmon moved in all directions throughout the Delta and no obvious migration pattern seemed to exist. Most of the tagged fish that were released at Jersey Point crossed back over to the Sacramento River. It appears that most of these tagged salmon were destined for the Sacramento River. We also discovered that sonic-tagged salmon moved in a counterproductive manner. Many of these fish moved significant distances downstream from our Hood station. For instance, we recorded two such fish at our San Joaquin River monitoring station at Mossdale. We also found tagged salmon in unusual locations, including San Pablo Bay, the Sacramento Deepwater Ship Channel, and Napa River. In the coming months we hope to better understand the effects of north Delta flows on salmon movements and whether gate operations at the Delta Cross Channel are affecting salmon movements. DFG will present the final results at the IEP Annual Workshop at Asilomar Conference Center in Pacific Grove, California.

We continue to track white sturgeon fitted with sonic transmitters as they migrate up the Delta. These fish were tagged in San Pablo Bay in October 2001 and have been moving up the Delta. To date, we have found 28 of the 40 fish at various locations including San Pablo, Honker, and Grizzly bays; Sacramento and San Joaquin rivers; and Cache Slough. Most of the fish have been found in the bays and a few have made major downstream treks from the upper Delta. As the flows increase, we should encounter more tagged sturgeon in the Delta Cross Channel region and Sacramento River.

Rock Slough Monitoring Program

Jerry Morinaka (DFG), jmorinak@delta.dfg.ca.gov

The Contra Costa Water District used the Rock Slough intake intermittently and pumped water at a very low rate during the months of October, November, and December 2001. The water was primarily used for maintaining levels in the Contra Costa Canal and for blending with Old River and Los Vaqueros water. The average daily acre-feet pumped ranged from 19 to 26 acre-feet per day (23,400 to 32,000 cubic meters per day). Fish entrainment monitoring was not conducted in October and November, and monitoring resumed on a schedule of once a week in mid-December after juvenile chinook salmon started showing up at the SWP and CVP fish salvage facilities. No delta smelt or chinook salmon were captured in the sieve-net at the Rock Slough intake in December.

Old River Fish Screen Facility (Los Vaqueros) Monitoring Program

Jerry Morinaka (DFG), jmorinak@delta.dfg.ca.gov

A sieve-net was used to sample fish entrainment three times a week behind the fish screens at the Old River Fish Screen Facility from October through December 2001. Adult bigscale logperch, *Percina macrolepida* (mean: 90 mm FL); prickly sculpin, *Cottus asper* (mean: 63 mm FL); bluegill, *Lepomis macrochirus* (mean: 184 mm FL); and inland silverside, *Menidia beryllina* (mean: 85 mm FL) were the only fish species captured in the sieve-net behind the fish screens during those months. This is typical for monitoring behind the screens at this time of the year, when the only fish captured are adult fish that have been residing within the facility between the fish screens and the pumps. Sieve-net monitoring in front of the fish screens in addition to the entrainment monitoring behind the screens will be conducted three times per week from January through June 2002.

Osmerid Larval Key Development

Linda Rivard (DWR), lrivard@water.ca.gov; Lenny Grimaldo (DWR); Lisa Lynch (DFG); Johnson Wang (National Environmental Scientists); Brent Bridges (USBR); and Bradd Baskerville-Bridges (UCD)

We have completed morphometric measurements of delta smelt and wakasagi for development of the diagnostic osmerid fish key. Data were collected on several sizes of osmerid larvae ranging from 4.0 mm to 16.0 mm standard length. Most of the samples were obtained from culture operations. We will begin to analyze variability of key characteristics, and identify which measurements could effectively be used to differentiate the two species at the larval stage. Once we have determined the most distinct characteristics, we will set up a blind test to determine how effective these characteristics are when used as part of the identification key. Trained fish biologists and untrained personnel will be the participants of the test. Each participant will be given several larvae of unknown origin and the preliminary key, and then asked to identify each larva. some of these larvae will be subjected to alloenzyme analysis to independently verify the species identification. We expect the analysis and determination of these characteristics to be complete by fall 2002.

Method to Simulate Agricultural Diversion Entrainment

Virginia Afentoulis (DFG), vafentou@delta.dfg.ca.gov

The development of a mobile sampling device is crucial for properly assessing the effect of unscreened diversions on the early life stages of fish species of concern in different areas of the Sacramento-San Joaquin Delta and Suisun Marsh. DFG proposes, with the aid of DWR, to design and construct a mobile sampling device that will in effect mimic the operation of the unscreened siphon diversion at Sherman Island. A Hydrostal centrifugal "fish friendly" pump, 50-foot work boat, and 20-inch diameter pipes will be the main components of the sampling structure. Once constructed, the mobile sampling device will be tested and compared (concurrently) with the DWR siphon diversion at Sherman Island in the spring of 2003. The pump has been purchased and the purchase of the work boat is in progress. Preliminary design of the apparatus has begun and we plan to build and test the pilot structure by fall 2002.

Project Work Team Profile

Resident Fish Communities in the Delta and Its Tributaries: A Meeting Summary

Project Work Team and Meeting Overview

Fred Feyrer (DWR), ffeyrer@water.ca.gov

On November 8, 2001, the IEP Resident Fishes Project Work Team hosted a meeting on resident fish communities in the Delta and watershed. The purpose of the meeting was to bring together scientists working with resident fish communities to share results and ideas on how to restore native fish populations in the system. The participants were in various stages of work, such as planning and analysis of results, but even submitted and published manuscripts were presented. The topics discussed during the meeting covered a geographic scope from Suisun Mash through the major tributaries of the Sacramento and San Joaquin rivers. A common finding of was that non-native species dominated the fish communities. Even the Cosumnes River drainage, an unregulated system exhibiting what could be considered the most “natural” habitat and ecosystem processes in the entire region, was generally dominated by non-natives. Overall, native species outnumbered non-natives in only a few locations in the upper Sacramento River drainage. The abundance of native species was typically seasonal and linked to key environmental variables. A group discussion following the presentations suggested water temperature, river flow, and possibly salinity are the most important abiotic variables forcing the ratio of native to non-native species; however, no specific management recommendations relating to native species enhancement were identified. It was clear that current research is heavily focused on macro-level correlative studies of fish abundance and abiotic environmental variables. Studies focused on micro-habitat use by species (especially Delta fishes), biotic interactions, and experimental approaches would greatly expand our current knowledge and ability to manage the system for the recovery of native species.

The remainder of this article consists of talk summaries provided by the speakers. In addition to those listed below, presentations were also made on the Suisun Marsh (Robert Schroeder, UCD); Cosumnes River (Pat Crain, UCD), Mokelumne River (Joe Merz, EBMUD); and the upper Feather River drainage (Tom Keegan, ECORP).

Delta Resident Shoreline Fish Monitoring Project

Dennis Michniuk (DFG)

The revised DFG Delta Resident Fish Monitoring Program started April 2001. The purpose of the program is to measure long term trends in resident fish abundance and community structure. The program will address the following questions:

1. What is resident fish abundance and community structure?

2. What are the relationships between biotic variables and habitat variables?

3. What negative or positive effects will habitat alteration have on resident fish?

4. Is there a need to change present angling regulations in order to protect resident species that are subject to a sport fishery?

This survey is a continuation of three previous surveys: (1) 1980–1983 Delta-wide stratified random survey; (2) 1984 Delta-wide monthly survey at 15 fixed locations; and (3) 1995, 1997, and 1999 surveys that consisted of 20 fixed locations sampled only during February, April, June, and August of those years.

In the new survey, sampling is conducted monthly at 15 half- kilometer-long randomly selected shoreline sampling sites throughout the Delta each month using a boat-mounted electrofisher. Random site selections are stratified by five areas of the Delta—two in the north and west, four in the east and central, and three in the south. Data to be collected at each site include fish counts; fish lengths of 50 individuals per species to the nearest millimeter; weights and stomach contents of five randomly selected individuals per species (stomach contents obtained through gastric lavage or dissection); bank composition; channel type; distance sampled; water depth, temperature, transparency, and specific conductance; light intensity; water velocity at beginning, end, and mid-channel; time shocked in seconds; electrofisher settings; and electrofishing difficulty. In addition, 400 large mouth bass are tagged each year with disk dangler tags to determine mortality rates and movement patterns.

Comparison of 2001 data with 1980–1983 data suggests that centrarchids were more abundant during 2001 and ictalurids were less abundant in 2001. Centrarchids were most abundant in the east Delta while ictalurids were most abundant in the south Delta. Thus far, stomach contents of 120 fish have been examined. Major prey items include arthropods such as Gammaridae in bluegill and largemouth bass; Cladocera and Chironomidae in channel catfish; and Gammaridae, *Corophium*, and Chironomidae, all found in redear sunfish.

Lower Feather River Fish Studies

Alicia Seesholtz and Brad Cavallo (DWR)

Studies of the Feather River downstream of Lake Oroville are designed to evaluate the effect of project operations on fish communities and river ecosystem functions.

Anadromous salmonids are the primary target of these studies, but information on other species is also being collected. Our presentation at the Resident Fish Project Work Team discussed data we have collected that relate to resident fishes.

The data were attained from studies that include seining, snorkeling and rotary screw trap sampling. Conducted throughout a 45-mile stretch of the Feather River, the seining element began in 1996 and samples monthly, year-round, with the most intense sampling occurring from March through September. Snorkel surveys began in 1999 and are conducted monthly, March through August, from the Fish Barrier Dam to Gridley. Sampling with rotary screw traps—one located upstream of Thermalito Outlet and the other in Live Oak—began in 1996 and is conducted daily from December through June.

The different sampling techniques provide surprisingly similar characterizations of fish assemblages in the lower Feather River. The most abundant species collected by these sampling types are chinook salmon (*Oncorhynchus tshawytscha*), Sacramento sucker (*Catostomus occidentalis*), Sacramento pike minnow (*Ptychocheilus grandis*), wakasagi (*Hypomesus nipponensis*), and steelhead (*Oncorhynchus mykiss*). Analysis indicates that patterns in fish species occurrence and abundance are explained by water temperatures and river mile. Cold water fishes (chinook salmon, steelhead, and cottids) tend to dominate upstream communities in the Low Flow Channel, while a warm water assemblage of fishes, consisting of tule perch (*Hysterocarpus traski*), western mosquitofish (*Gambusia affinis*), centrarchids, and cyprinids is evident in the lower portions of the Feather River. The outlet of water from Thermalito Afterbay demarcates the boundary between these fish communities. The river below Thermalito Outlet is appreciably warmer (in summer) and enriched with planktonic organisms flushed out of the shallow and mesotrophic afterbay. Generally, native fishes such as tule perch, hardhead (*Mylopharodon conocephalus*), hitch (*Lavinia exilicauda*), Sacramento sucker, and Sacramento pike minnow are abundant in the lower Feather River below Thermalito Outlet and appear to be successfully coexisting with exotic centrarchids, anadromous exotics (striped bass and American shad), exotic minnows, and native anadromous salmonids.

Fish Community Structure in the Sacramento River Basin 1996–1998

Jason May and Larry Brown (USGS)

In general, resident stream fishes in the Sacramento River Basin during 1996–1998 appeared to respond to a longitudinal gradient in physical environmental conditions. Additionally, native fish species remain widely distributed throughout the basin, with the exception of agricultural drains where introduced species are dominant (May and Brown forthcoming). Univariate and multivariate statistical analyses indicated species distributions were correlated with elevational and substrate size gradients; however, the elevation of a sampling site was correlated with a suite of water quality and habitat variables that are indicative of land use effects on physiochemical stream parameters. The results of the current survey were compared with recent studies in the San Joaquin River drainage (see Brown 2000) to provide a wider perspective of the condition of resident fish communities in the Central Valley of California, as a whole. These comparisons suggested differences in water management practices may have significant effects on native species fish community structure (Brown and Ford forthcoming). Additionally, the results of the current study suggest select sites within the Sacramento River Basin may serve the function of representing less-affected conditions for restoration goals of resident fish communities for the entire Central Valley, California.

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Patterns of Adult Fish Use on California's Yolo Bypass Floodplain

Bill Harrell and Ted Sommer (DWR)

Here we describe initial results from a study to examine adult fish diversity, abundance, and timing of occurrence in the Yolo Bypass floodplain, a region of known importance for juvenile fish rearing. A large cylindrical fyke trap was used to capture adult fish between November 1999 and June 2000. We observed over 1,600 fish representing 19 species including federally listed winter-run and spring-run chinook salmon (*Oncorhynchus tshawytscha*), splittail (*Pogonichths macrolepidotus*) and sport fish such as white sturgeon (*Acipenser transmontanus*), striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*) during the sampling period. Flow pulses immediately preceding floodplain inundation apparently triggered upstream movement of a suite of native fish including splittail, sucker (*Catostomus occidentalis*), pikeminnow (*Ptychocheilus grandis*) and blackfish (*Orthodon microlepidontus*). However, we also observed immigration of chinook salmon, white sturgeon, American shad and striped bass during low flow periods, when there was no upstream connection to the Sacramento River. Concurrent screw trap sampling indicated these migrations resulted in successful spawning of splittail, American shad, and striped bass. These results indicate the Yolo Bypass floodplain represents an important migration corridor and spawning habitat for Delta fish; however, better upstream passage is needed particularly during low flow periods.

Fish Communities of the Lower San Joaquin River Drainage

Larry Brown (USGS)

Fish communities of the lower San Joaquin River (downstream of Salt Slough to Vernalis) and its three major tributaries (Stanislaus, Tuolumne, and Merced rivers downstream of the large foothill reservoirs) were dominated by introduced species based on survey data collected in 1994 (Brown 2000). The lower San Joaquin River was characterized by a group of four introduced species including threadfin shad, inland silverside, fathead minnow, and red shiner. Native species—primarily Sacramento sucker, Sacramento pikeminnow, hardhead, and sculpins—were most abundant in the tributary rivers in the upstream reaches close to the large foothill reservoirs. Introduced species dominated lower elevation tributary sites closer to the San Joaquin River. Canonical correspondence analysis of the data indicated specific conductance, river gradient, and mean depth were strongly correlated with the patterns in fish relative abundance. Specific conductance and other physical and water quality measures were strongly correlated with agricultural land use. Analysis of winter-spring seining data from the Tuolumne River downstream of Don Pedro Reservoir collected from 1987 to 1997 also indicated that native species were most abundant in upstream areas and that introduced species dominated downstream areas (Ford and Brown 2001; Brown and Ford forthcoming). In addition, April-May flow was strongly correlated with the relative abundances of native and introduced species. A regression model including distance from the San Joaquin River and April-May flow the previous year explained 67% of the variance in the percentage of introduced fish captured at a site. These results support the hypothesis that flow regime is an important determinant of fish community structure in California rivers and streams.

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Fish Community Structure and Environmental Correlates in the Highly Altered Southern Sacramento-San Joaquin Delta

Fred Feyrer (DWR) and Mike Healey (DFG)

Eleven sites in the southern Sacramento-San Joaquin Delta were sampled over eight years, 1992–1999, to characterize fish communities and their associations with environmental variables. Within the sampling area riparian habitats are dominated by rock-reinforced levees and large water diversion facilities greatly influence local hydrodynamics and water quality. Over the study period, 33 different taxa were captured—only eight were native. None of the native species represented greater than 0.5% of the total number of individuals collected over the study period. Fish communities were primarily structured along environmental gradients of water temperature and river flow. Native species (tule perch, *Hysterocarpus traski*, and Sacramento sucker, *Catostomus occidentalis*) were associated with conditions of relatively high river flow and turbidity, while the majority of the non-native species were associated with either warm water temperature or low river flow conditions. The exceptions were the non-native species striped bass, *Morone saxatilis*, and white catfish, *Ameiurus catus*, which were positively associated with relatively high river flow. Variation in fish community structure was greater among locations within years than within locations among years, which indicated that fish communities at each location were consistently different each year. Differences in fish communities among locations were correlated with differences in river flow among the locations. We believe that the fish communities of this region will remain numerically dominated by non-native species if the environmental conditions we observed persist in the future.

NEWS FROM AROUND THE ESTUARY

Introduced Palaemonid Shrimp Invades the Yolo Bypass Floodplain

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Introduction

The San Francisco estuary is a highly altered and invaded ecosystem. Invasive aquatic species have significant effects on food web dynamics and have contributed to the extirpation of organisms native to the system (Cohen and Carlton 1995). Once established, invasive, non-native species may prey upon native organisms at lower trophic levels, become prey items themselves, or negatively affect native organisms that occupy a similar niche. Some recent examples of invaders to the San Francisco Estuary include the Asian clam (*Potamocorbula amurensis*), shimofuri goby (*Tridentiger bifasciatus*), and the Chinese mitten crab (*Eriocheir sinensis*). One of the most recent invaders is a Palaemonid shrimp, identified as *Exopalaemon modestus* (see quarterly highlight by Kathy Hieb on page 4). Here we report our initial observations on the shrimp in the Yolo Bypass, the largest floodplain of the San Francisco Estuary. We first collected small numbers of the shrimp during January 2001; however, the species has subsequently become one of the dominant species in the floodplain. Additional collections have been made by DFG's spring midwater trawl survey near Rough and Ready Island, by the USFWS at Liberty Island, and by DFG near Sherman Island (Souza 2001).

Field Observations

Although the Yolo Bypass study is not specifically designed to capture and enumerate macroinvertebrates; the project uses a variety of techniques (Sommer and others 2001) that have provided data on the new shrimp.

The following are observations from seasonal screw trap and monthly beach seine sampling in the Yolo Bypass, both of which now consistently collect this new Palaemonid shrimp. Additionally, a study of floodplain ponds in the Yolo Bypass (see article by Feyrer and others on page 9) has collected shrimp from ponds other then those sampled in the monthly beach seine survey.

The occurrence, relative sizes, and presence of eggs of these shrimp all were recorded; however, beginning in June all shrimp taken in beach seine sampling also were counted. Shrimp were counted and weighed to estimate their biomass per unit area for the floodplain pond study.

Rotary Screw Trap Sampling

The Yolo Bypass Study rotary screw trap is located about 23 kilometers downstream (south) of the I-80 causeway in the Yolo Bypass Toe Drain (a perennial tidal channel). During 2001 screw trap sampling was conducted from January through June. Shrimp were first collected in the screw trap on January 30, twenty-eight days after it began fishing. Non-gravid shrimp were taken intermittently in the screw trap until March 26, when the first, large gravid individuals were observed (Figure 1). After this date both large and mid-size shrimp were observed with eggs until the end of the sampling season. In addition to the large and mid-size classes, there was a small size class that was never observed with eggs (Figure 2). A "larval" stage was observed intermittently after March 26, but the mesh size of our dip-nets was too large to retain them.

Figure 1 Large gravid palaemonid shrimp collected at the rotary screw trap site in March 2001

Figure 2 Three shrimp representing commonly observed sizes (small, medium, and large) in the Yolo Bypass. "Larval" class not shown.

Beach Seine Sampling

Three sites in the Yolo Bypass are sampled a minimum of once a month throughout the year, with additional sites during high flow events. The three beach seine sites include the screw trap site in the Toe Drain, the Yolo Basin study pond located just north of the I-80 causeway, and a perennial pond located near Fremont Weir. Shrimp were first taken during the beach seine survey on May 31, 2001, at the screw trap site. These were very small shrimp, possibly young of the year. On June 25 shrimp were first taken in the Yolo Basin study pond and on August 20 they were first observed in Fremont Weir pond. Beginning in June, all shrimp taken in the beach seine were counted. Using area calculations for the beach seine, we were able to calculate catch per unit effort for June through December (Table 1).

Table 1 Catch per unit effort (number per cubic meter) of shrimp taken in the monthly Yolo Bypass beach seine survey

	Yolo Basin study pond		*Screw trap site*		*Fremont Weir pond*	
Month	*Number*	*CPUE*	*Number*	*CPUE*	*Number*	*CPUE*
Jun	120	1.067	75	3.099	0	0.000
Jul	68	0.302	328	72.889	0	0.000
Aug	115	0.568	45	1.023	4	0.056
Sep	179	1.326	104	1.444	18	0.190
Oct	20	0.111	324	10.286	89	1.978
Nov	147	0.817	20	0.238	11	0.170
Dec	1196	10.631	125	2.572	36	0.556

Floodplain Pond Study

In a separate study designed to evaluate fish assemblages in perennial floodplain ponds (see article by Feyrer and others on page 9), shrimp were found in four of the seven study sites during summer 2001. These four ponds all had some connectivity with the Toe Drain canal during the localized winter flood events of 2001, or as part of water management methods for waterfowl in the Yolo Basin Wetlands. Generally, between pond variance and within pond variance of shrimp densities in beach seine samples was high. Seine hauls that captured shrimp had densities from 0.004 to 2.00 individuals per m^2 (1 to 450 individuals per 225 m^2). Biomass, estimated in 5 of the 16 samples containing shrimp, ranged from 0.14 to 0.30 g/m^2.

Discussion

Despite its relatively recent appearance, the new palaemonid shrimp has become one of the most commonly captured organisms in Yolo Bypass. As evidenced by our catch per unit effort data (Table 1) shrimp catch has been highly variable. We do not know if this patchiness is due to the selectivity of the sampling gear (beach seine, screw trap), environmental variables, or shrimp life history. In any case, our goal for the present year is to more consistently quantify the catch of this species. Several changes in sampling methods have been incorporated to enumerate catch, size class, and reproductive status.

We do not yet have any indication of whether the shrimp will have a substantial effect on the ecology of the Yolo Bypass floodplain. Given the unpredictability of previous aquatic invaders (Moyle and Light 1996), we have no idea which trophic levels might be affected. Our hope is that ecological data collected in the Yolo Bypass since 1997 will provide an adequate baseline to assess the effects of this new invader on the aquatic ecosystem.

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Daphnia lumholtzi Detected Again

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Daphnia lumholtzi is a cladoceran native to Australia, Asia, and Africa. On July 21, 1999, it was found in zooplankton samples taken on a CALFED sampling cruise in Clifton Court Forebay. (Mueller-Solger 2001). However, it has not shown up in DFG zooplankton monitoring samples in the Delta. Nor was it found in 15 DWR-UCD samples taken in Clifton Court Forebay from August 21 through September 30, 2001. Is *D. lumholtzi* still present in the Delta or has it been eliminated? Recently this question was answered when a specimen of *D. lumholtzi* was found in a U.S. Geological Survey sample taken at Mildred Island on September 5, 2001. The specimen was immature but measured 1.2 mm from eye to end of valves. The large head and tail spines that characterize this species added another 2 mm to its length.

From 52 USGS samples taken at Mildred Island in late August and early September, only one contained *D. lumholtzi*. Thus, this exotic species persists in the Delta, yet at very low densities. This suggests other and as yet unreported exotic species may also be present in very low abundance in the estuary. These organisms could function as "sleepers,"—to borrow a term from international terrorism—they would remain undetected for years by monitoring activities and then, when conditions change and become favorable, they could "explode."

Reference. Mueller-Solger A. 2001. First observation of an exotic water flea in the delta: *Daphnia lumholtzi*. IEP Newsletter 14(3):12–4.

Water Year Hydrologic Classification Indices for the Sacramento and San Joaquin Valleys

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The Water Year Hydrologic Classification Index is an excellent reference for a quick and accurate summary of the water year, the period beginning October 1 and ending September 30.

Water year classifications are based on unimpaired runoff. Unimpaired runoff corresponds to the natural water production of a river basin, unaltered by diversions, storage, and water exports. Sacramento River runoff is the summation of the Sacramento River at Bend Bridge, the Feather River inflow to Lake Oroville, the Yuba River at Smartville, and the American River inflow to Folsom Lake. San Joaquin River runoff is the summation of the Stanislaus River inflow to New Melones Lake, the Tuolumne River inflow to New Don Pedro Reservoir, the Merced River inflow to Lake McClure, and the San Joaquin River inflow to Millerton Lake.

The hydrologic classification indices are computed in accordance with the State Water Resources Control Board's Water Right Decision 1641. Pursuant to D-1641, the Sacramento and San Joaquin hydrologic indices determine the water year type for the entire state. In turn, the water year type determines operations for the State Water Project and the Central Valley Project by determining the objectives that must be met. This has wide reaching ramifications. For example, fish take limits and all water quality objectives in the Delta are calculated based on water year type.

Water Year classifications are based on the Sacramento Valley 40-30-30 and the San Joaquin Valley 60-20-20 hydrology for the water year; two separate calculations are used to calculate each index.

The Sacramento Valley 40-30-30 Water Year Hydrological Classification Index is calculated as:

0.4 x the current April to July unimpaired runoff +

0.3 x the current October to March unimpaired runoff +

0.3 x previous year's index.

If the previous year's index exceeds 10.0, then 10.0 is used.

Water year hydrologic classifications for the Sacramento Valley are defined as follows:

- Wet. . . . . ≥ 9.2
- Above Normal . . . . >7.8 and ≤ 9.2
- Below Normal . . . . >6.5 and ≤ 7.8
- Dry . . . . >5.4 and ≤ 6.5
- Critical . . . . ≤ 5.4

The San Joaquin Valley 60-20-20 Water Year Hydrological Classification Index is calculated as:

0.6 x current April to July unimpaired runoff +

0.2 x current October to March unimpaired runoff +

0.2 x previous year's index.

If the previous year's index exceeds 4.5, then 4.5 is used.

Water year hydrologic classifications for the San Joaquin Valley are defined differently, as shown below:

- Wet. . . . . ≥ 3.8
- Above Normal . . . . >3.1 and <3.8
- Below Normal . . . . >2.5 and ≤ 3.1
- Dry . . . . >2.1 and ≤ 2.5
- Critical . . . . ≤ 2.1

Many biologists and engineers use the hydrologic indices to ask questions about historical events and to interpret long-term status and trends. For example, the Asian clam, *Potamocorbula amurensis*, established itself in the estuary in 1987. Water years 1987 through 1992 were all classified as dry or critical years. Did the salinity intrusion give *P. amurensis* the opportunity to establish itself? Or was it something else? During this time the other Asian clam species, *Corbicula fluminea*, experienced a drop in abundance throughout the eastern and central Delta. Was this also because of salinity intrusion?

In a dynamic environment such as the Sacramento-San Joaquin Delta, hydrologic indices are excellent tools for biologists to use when developing study plans and explaining temporal differences in physical conditions (such as temperature and specific conductance), or biological conditions (such as fish and crab recruitment).

All hydrologic classification information is available from the California Department of Water Resources' California Cooperative Snow Surveys. Snow Survey data are available on the DWR-maintained CDEC website at http://cdec.water.ca.gov.

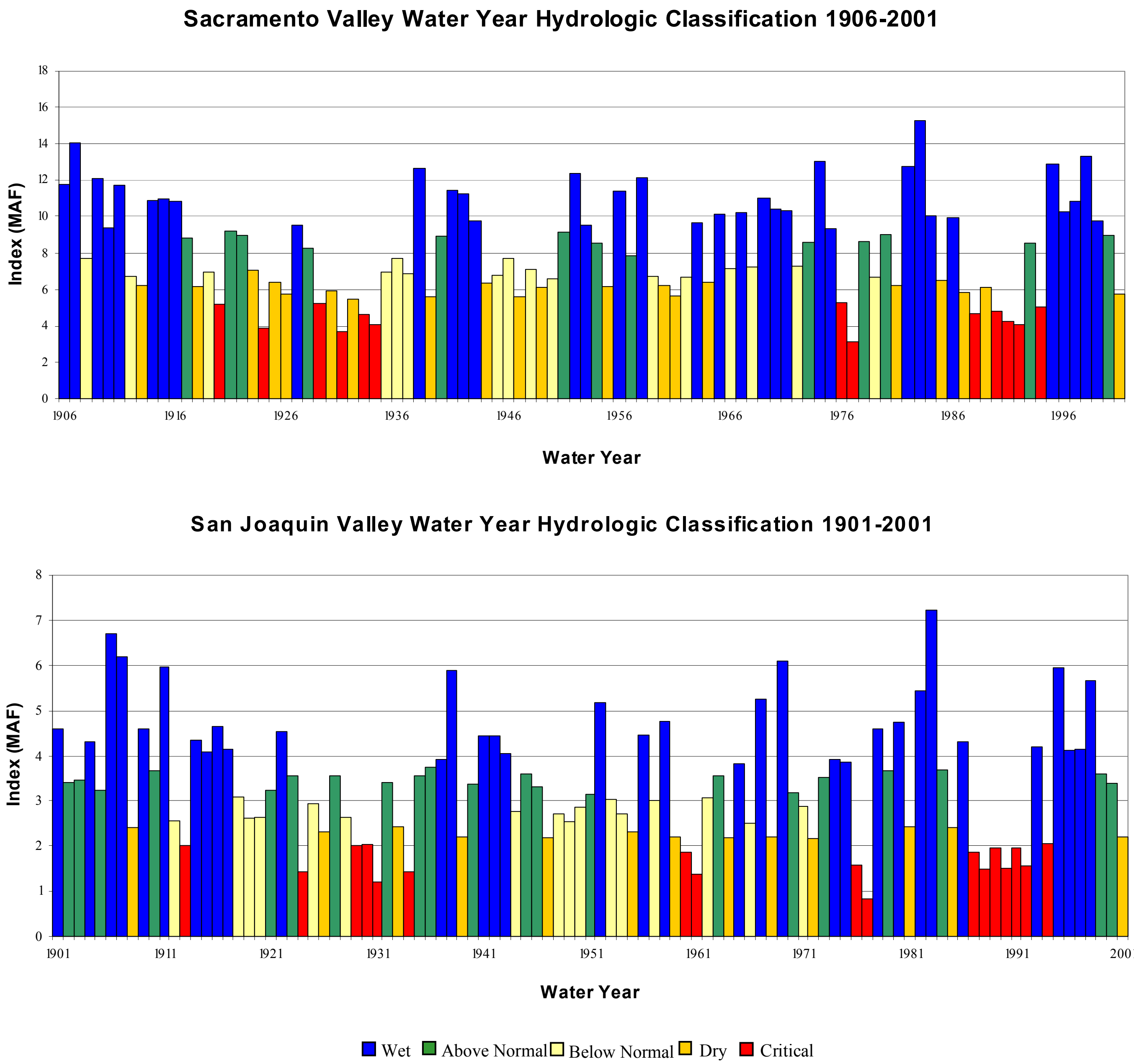

Figure 1 Water year hydrologic classification indices for the Sacramento and San Joaquin valleys. Note differences in scale in million acre-feet (MAF) for each graph. Data collected for the Sacramento Valley watershed begins in 1906. Data collected for the San Joaquin watershed begins in 1901.

Sea Grant Study Finds Chinese Mitten Crabs Appear Free of Human Parasite Lung Flukes

Adapted from a news release submitted by Gerald Hatler, DWR. Contact: Carrie Culver, National Sea Grant College Program, c_culver@lifesci.ucsb.edu

A study funded by California Sea Grant suggests Chinese mitten crabs (*Eriocheir sinensis*) in the San Francisco Bay Estuary are not infected with a dangerous human parasite that has caused deaths in Asia.

Jenifer Dugan, Mark Walter and Carrie Culver of the Marine Science Institute at the University of California at Santa Barbara analyzed tissue samples from more than 800 mitten crabs collected in the bay—not a single crab was shown to be infected with either Asian or North American lung flukes. The crabs were collected at 15 to 20 sites over a two-year period beginning in 1999.

Dugan said, "We have not found any evidence of lung flukes. There have been a few other parasites found, but only in a couple of specimens. The crabs seem to be healthy and thriving. Nonnative species may flourish in a new habitat because they have escaped many of their native predators and parasites."

Lung flukes are parasites with a complex lifecycle that requires them to infect two intermediate hosts before they mature into adults inside a warm-blooded animal or person. Flukes in their "larval" form infect snails, then crustaceans, such as mitten crabs and crayfish. In mammals, they attack the respiratory system as they reproduce.

In Asia, where mitten crabs are a delicacy, people regularly suffer lung damage from eating infected seafood. The flukes can also spread to the brain.

State health officials have been concerned that mitten crabs in the San Francisco Bay area might also carry lung flukes, thereby posing a a health risk to recreational fishers. Although commercial fishing for the crabs is prohibited, sport fishing is allowed, and people do eat the crabs. Live females with eggs can sell for more than $20 each in Asian markets, although the sale and transport of live mitten crabs is illegal in California, an effort to curb their spread.

Chinese mitten crabs are native to China and Korea but are a highly invasive nuisance species elsewhere. The crabs were first identified in California in 1992, after a shrimp trawler working the South San Francisco Bay hauled up a strange looking crab with fuzzy claws.

However, the crab most likely was introduced to San Francisco South Bay much earlier, in the late 1980s. A hearty and fecund invader, the crab has multiplied to such numbers that it may overrun parts of the bay. In 1998, state workers hauled away about 50 tons worth of mitten crabs that had adversely affected fish salvage operations at state and federal water export facilities in the Delta. Besides clogging fish salvage tanks, mitten crab burrows may undermine banks and levees, accelerating erosion and unwanted slumping. Adverse effects to banks and levees have not been detected in the Delta.

To date, there are no strategies in place for controlling the crab's numbers. Fishers are suggesting that the crab population be culled by opening the mitten crab to commercial fishing, but this is problematic, too. Dugan said, "The idea is to figure out a way to get rid of the crabs. If you open a fishery, suddenly, they have a value."

Another concern is that parasites could spread like fire in a hayloft through the bay at some later date, because of the sheer number of crabs. Not just people but also raccoons and other animals that feed on mitten crabs could be infected.

Because crayfish are a potential intermediate host for the flukes, the scientists also dissected more than 400 crayfish from the estuary. Like the crabs, all the crayfish appear free of lung flukes. Despite their findings, the scientists are cautious about concluding that eating the crabs is safe now or in the future. "Until we finish our survey of the region's snails," Walter said, "we can't assess the risk of future introductions of lung flukes."

The scientists are analyzing hundreds of freshwater snails from the area to look for evidence of lung flukes. "Even if the snails turn up clean," Culver said, "there are other major health concerns, such as bioaccumulation of contaminants like mercury, selenium, arsenic and DDE (a by-product of DDT) in the crabs."

Culver sits on the Mitten Crab Control Committee of the Aquatic Nuisance Species Task Force, which has been asked to develop and oversee the implementation of a management plan. Culver says the committee is addressing four main issues: preventing the crab's spread; detecting new populations; reducing its negative effects; and controlling its numbers. The IEP also has a mitten crab technical committee.

CONTRIBUTED PAPERS

A Survey to Examine the Effects of the Chinese Mitten Crab on Commercial Fisheries in Northern California

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Introduction

The recent arrival of the Chinese mitten crab (*Eriocheir sinensis*) to the San Francisco Estuary has caused widespread concern about the potential ecological and economic effects of this species in its new environment. First discovered in 1992 by a shrimp trawler in South San Francisco Bay, the mitten crab population has quickly expanded to thousands of square kilometers of the estuary and its tributaries.

The abundance, widespread distribution, and potential negative effects of this crab have particularly caused concern among members of the estuary's fishing community. The mitten crab is catadromous; it begins its life in the saline waters of the bay and migrates up into fresh waters to mature. After one to five years in these waters, it returns in the fall to the open waters of the bay to reproduce. The mitten crab is an excellent migrator, and may cover hundreds of kilometers of a river during its lifetime. The crab is omnivorous, but may shift to a more carnivorous diet as it ages (Tan 1984). The likelihood that the crab is able to capture free-swimming fish is low—we and other researchers have kept these crabs and fish in containment together and observed little interaction between them (Panning 1939; D. Rudnick, personal observation, see "Notes"). However, mitten crabs have extremely sharp carapaces and claws and, when captured in fishing gear with the intended catch, they have been reported to cause damage to catch (Panning 1939). At periods of high abundance in the estuary, mitten crabs have become a serious nuisance by stealing bait from recreational anglers (K. Hieb, personal communication, see "Notes"). They can also be a hindrance by fouling fishing lines and gear.

Little research has been conducted in this system or in other parts of the world where the crab has been introduced to identify and quantify the crabs' effects on commercial fishing efforts. Because commercial fishers are continuously working in the bay, they could provide a wealth of knowledge about the distribution, abundance, and behavior of the crab. Our objectives were therefore twofold: (1) to identify and quantify the negative effects of the Chinese mitten crab on commercial harvest of San Francisco Bay seafood; and (2) to establish the potential for data collection by commercial fishermen to increase our understanding of the ecology of this species.

Methods

We applied and received permission to obtain contact information for commercial fishing licensees in California from the Department of Fish and Game. Licensees were not identified in the database by the area in which they fish or by their target species, so we narrowed the list to those with contact information in the San Francisco Bay area. We then randomly chose 30 contacts to receive the survey.

Our survey was mailed with a cover letter explaining the purpose of our study and confirming that responses would be used anonymously and collectively, unless the recipient agreed otherwise. This survey was developed with the assistance of the UC Berkeley Survey Research Center. Survey questions confirmed: the type of fishery the recipient was engaged in; the equipment used; the area in which they fished; whether, when, and how often mitten crabs were collected; and if damage to the harvest was observed in the presence of the crabs. Recipients were invited to provide further contact information and indicate if they would be willing to participate in further research.

The survey was mailed in September of 2000. If, after 30 days, no response was received, we followed up with a phone call to the recipient to ensure that the survey was received, that it was pertinent to them (that is, that they fished in the San Francisco Estuary), and to ask if they had further questions. Respondents who were willing to continue to participate were sent data collection sheets to more closely and continuously track mitten crab collections.

Results

Nine completed surveys were returned by mail—a one-third response rate. Two surveys were returned in the mail indicating incorrect addresses and telephone numbers also were incorrect. Following up by telephone, four additional recipients indicated that they did not fish in or near San Francisco Bay, had never seen a mitten crab, and therefore, did not return the survey. Of respondents who returned surveys, two fished outside the bay and had never collected mitten crabs.

All respondents who were actively fishing in the bay or Delta reported capturing mitten crabs either as bycatch or on the outside of their fishing equipment. Respondents fished for a variety of seafood (shrimp, gobies, sculpin, crayfish, and herring) using a variety of gear types (trawl nets, gill nets, hook and line, and traps). All respondents reported their first capture of mitten crabs in 1995 or 1996.

Mitten crabs were reported year-round during fishing efforts, but the highest numbers of crabs were reported during winter months (November-February) (Figure 1).

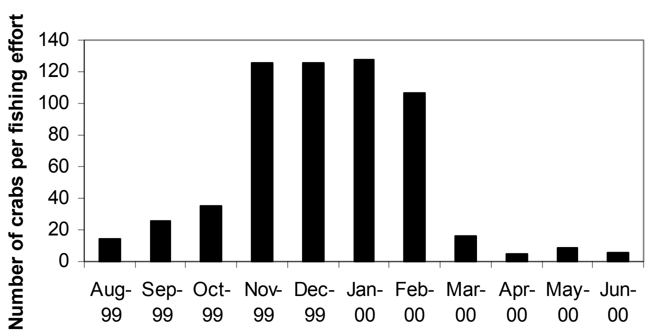

Figure 2 Average number of crabs per fishing effort, 1999–2000

All five respondents that were engaged in shrimping using trawl nets reported damage to their catch. Effects included damage to and death of catch as a result of being pressed against the spiny carapace of the crabs, and increased time for cleaning of equipment because of crabs being tangled in nets and lines. Estimates of direct damage to shrimp from the crabs ranged from 5% to 40% of catch during periods of high mitten crab abundance. One respondent indicated that mitten crabs were actively eating shrimp in the net; others remarked that most damage occurred from the spiny carapace and legs of the crabs puncturing the shrimp.

Two respondents, one fishing for crayfish using traps and one fishing for herring using gill-nets, reported no discernible damage to catch by mitten crabs.

Discussion

The results of this survey align closely with what is known about the life history of the Chinese mitten crab. Mitten crabs are present year-round in the brackish portions of tributaries, but reach their highest densities in their breeding grounds in winter months, also the time when respondents reported the highest numbers of crabs. Damage to and interference with commercial harvests is therefore concentrated in this season.

Juvenile and adult mitten crabs are benthic animals, grazing on detritus and other food sources at the bottom of the water column; therefore, the highest rates of capture should occur when using methods that collect animals from the bottom of the estuary, such as trawling. Benthic stationary traps, as are used in the crayfish industry, often do not attract crabs, as was observed in this survey and others and research that we have conducted (Rudnick and others 2000). The shrimp industry, which uses low-speed trawls to harvest shrimp, is the industry that reported the highest level of damage in this survey, and should be targeted for further research and identification of the Chinese mitten crab's effects on commercial fishing.

We received many individual comments and suggestions from respondents that, while not quantifiable, provide valuable information and directions for further inquiry. Observations included noticing an inverse relationship between the speed of the trawl and the number of mitten crabs collected; remarking on high abundance of mitten crabs and higher levels of salinity and/or depth; and wondering about possible connections between the increase in mitten crabs and decline of other species such as Dungeness crab. One respondent also emphasized the link between commercial and recreational fisheries affected by the mitten crab, stating that recreational fishermen who buy his products for bait have become so frustrated by losing bait to these crabs that they have stopped buying his products, causing his sales to decline.

Our survey was limited by several factors, including no prior information of where survey recipients fished and what seafood was harvested. Prior knowledge of this information would have ensured that recipients were appropriate for the survey and ensured coverage of the range of industries operating in the estuary. In addition, follow-up efforts to ensure surveys were complete were often difficult, because industry members are extremely busy and hard to contact.

We believe that the quantity and quality of data received provided useful information about mitten crab effects to these industries. Four respondents have agreed to collect long-term data on mitten crabs captured during their fishing efforts, and this year we have begun coordinating reporting and analysis of these data. These new data should enable us to better understand relationships among gear type, gear use, and crab collection rates, as well as provide more specific information about location of collections and relation to physical, chemical, and temporal parameters.

Conclusions

Potential negative effects of invasive species are often cited as the basis for developing policies for management and control of these species, but we often do not have the information needed to quantify these effects. We have identified effects to fishing industries by the Chinese mitten crab, including damage to and preying on catch, reduction in sales of bait fish, and increased time spent separating crabs from catch. In our survey, effects were concentrated in the shrimping industry, and this industry should be a target for further research and management considerations.

The Chinese mitten crab's historical invasions of the waterways of several European countries suggests its population abundance oscillates, and several years of low abundance may be followed by a population explosion. There is still much that needs to be understood about the population dynamics and life history of this species. Commercial and recreational fishermen can be valuable allies in tracking this population, increasing our knowledge about its life history, and helping us understand the extent of its effects in the San Francisco Estuary.

Acknowledgements

We thank the California Department of Fish and Game for sharing licensee data, Kathryn Hieb (DFG) for input and information on commercial and recreational fisheries, and especially the survey respondents. This research has been supported by a grant from CALFED.

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Notes

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Water Level, Specific Conductance, and Water Temperature Data, San Francisco Bay, California for Water Year 2000

Paul A. Buchanan (USGS), buchanan@usgs.gov

Time series of water-level, specific-conductance, and water-temperature data were collected at seven sites in San Francisco Bay during water year 2000 (October 1, 1999 through September 30, 2000). Water-level data were recorded only at Point San Pablo. Specific-conductance and water-temperature data were recorded at 15-minute intervals at the following locations (Figure 1):

- Carquinez Strait at Carquinez Bridge
- Napa River at Mare Island Causeway near Vallejo
- San Pablo Bay at Petaluma River Channel Marker 9
- San Pablo Strait at Point San Pablo
- Central San Francisco Bay at Presidio Military Reservation
- Central San Francisco Bay at Pier 24
- South San Francisco Bay at San Mateo Bridge near Foster City.

Data from Point San Pablo, Presidio, Pier 24, and San Mateo Bridge were recorded by the California Department of Water Resources (DWR) before 1988, by the U.S. Geological Survey (USGS) National Research Program from 1988 to 1989, and by the USGS-DWR cooperative program since 1990. The Carquinez Bridge, Napa River, and San Pablo Bay sites were established in 1998 by the USGS.

Specific-conductance and water-temperature data were collected at near-surface and near-bottom depths in the water column to define vertical stratification. However, at the more shallow San Pablo Bay and Presidio sites, where mean lower-low water depth was about 6 feet, data were collected only at near-bottom depths. The San Mateo Bridge site, shut down in March 1999 for seismic retrofitting of the bridge, was reestablished June 14, 2000, although the upper conductivity recorder was not operational until November 15, 2000. The monitoring site at Point San Pablo was discontinued on January 1, 2001, when the lease expired.

Several types of instrumentation were used to measure specific-conductance and water-temperature in San Francisco Bay. Instrument selection primarily was based on the availability of alternating current power at the monitoring site. Specific conductance [reported in microSiemens per centimeter at 25 °Celsius (C)] was measured using either a Foxboro electrochemical analyzer (calibrated accuracy ±3 percent) or a Hydrolab Datasonde 4 multiprobe (conductivity cell calibrated accuracy ±1 percent). Water temperature (reported in degrees Celsius) was measured using a Campbell Scientific thermister (accuracy ±0.4 °C) or the Hydrolab Datasonde 4 multiprobe (temperature probe accuracy ±0.1 °C). Water level (reported in feet) was measured using a Handar incremental encoder with a float-driven, incremental stainless-steel tape. Water-level, specific-conductance, and water-temperature measurements were recorded every 15 minutes.

Continuous-recording instrument field calibrations were completed every 2-3 weeks. Specific conductance instruments were calibrated using an Orion model 140 conductivity meter (calibrated accuracy ±2 percent) calibrated to a known specific conductance standard. Water-temperature instruments were calibrated using a VWR Scientific thermister (accuracy ±0.2 °C). Water-level instruments were checked using a wire-weight gage mounted to the pier at Point San Pablo. Data corrections (normally resulting from biological fouling or instrument drift), based on differences between the continuous-recording instrument readings and the field-calibrated instrument readings, were applied to the record for final computation using the USGS Automated Data Processing System.

Figures 2 through 6 are time-series plots of the specific conductance, water temperature, and water level measured at the seven sites in San Francisco Bay; gaps in the data primarily are due to equipment malfunctions. Tidal variability (ebb and flood) affects water level, specific conductance, and water temperature (Cloern and others 1989; Ruhl and Schoellhamer 2001). In the time series, the degree of tidal variability corresponds with the vertical range of the time-series data. To illustrate, Figure 7A shows water level and Figure 7B shows the near-surface and near-bottom specific conductance at Point San Pablo for the 24 hours of October 1, 1999. Tidal variability is greater in San Pablo Bay than in South San Francisco Bay (Schoellhamer 1997).

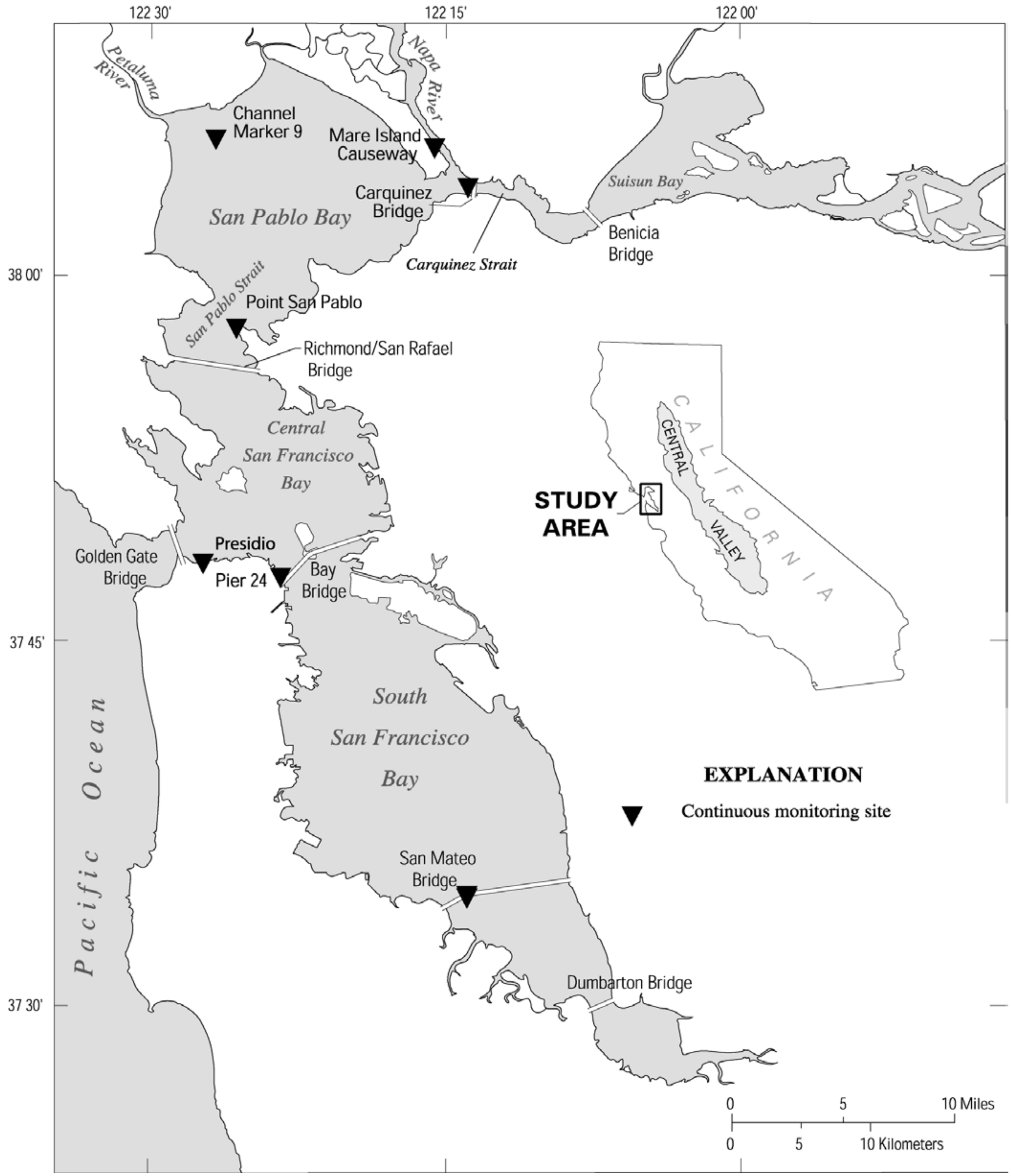

Figure 1 Water-level, specific-conductance, and water-temperature monitoring sites in San Francisco Bay, California

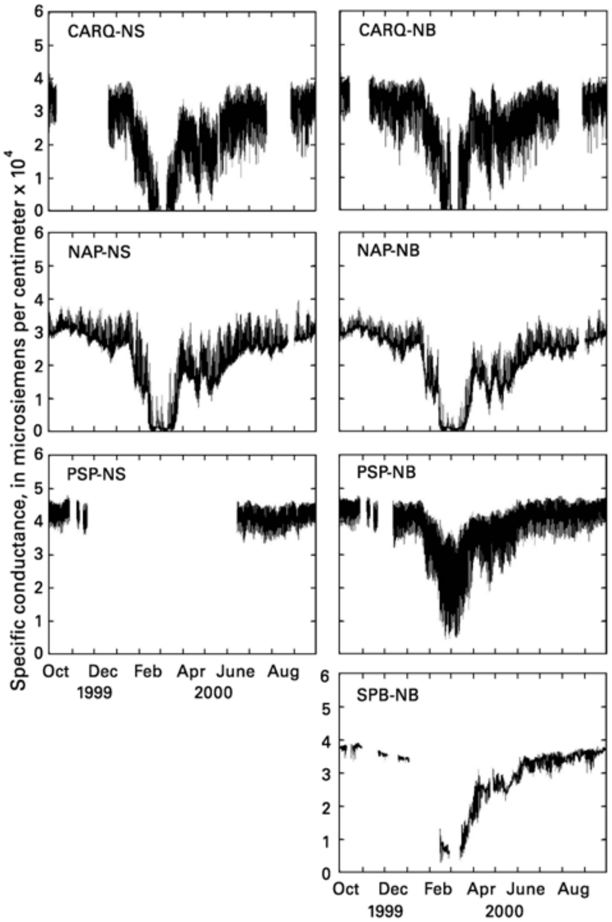

Figure 2 Near-surface (NS) and near-bottom (NB) measurements of specific conductance at Carquinez Bridge (CARQ), Napa River (NAP), Point San Pablo (PSP), and San Pablo Bay (SPB), San Francisco Bay, water year 2000. For reference, seawater has a specific conductance of 53,000 microSiemens per centimeter (5.3 x 10^4)

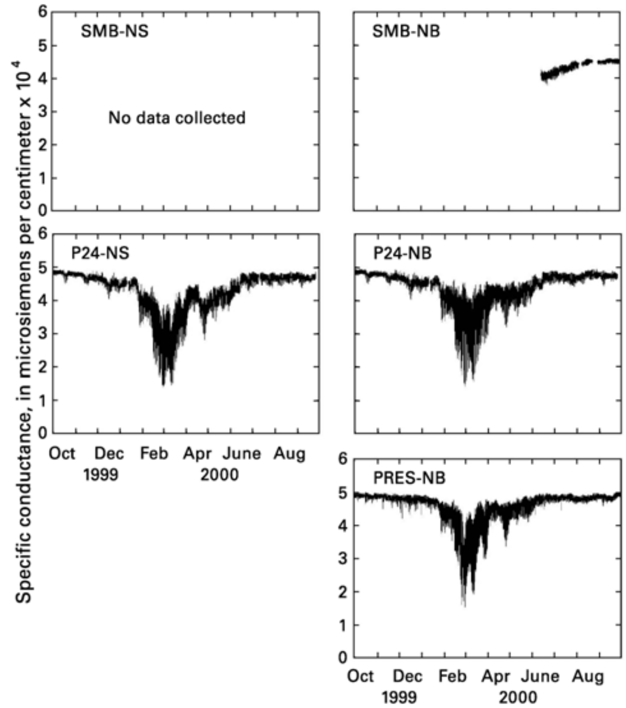

Figure 3 Near-surface (NS) and near-bottom (NB) measurements of specific conductance at San Mateo Bridge (SMB), Pier 24 (P24), and Presidio (PRES), San Francisco Bay, water year 2000. For reference, seawater has a specific conductance of 53,000 microSiemens per centimeter (5.3 x 10^4)

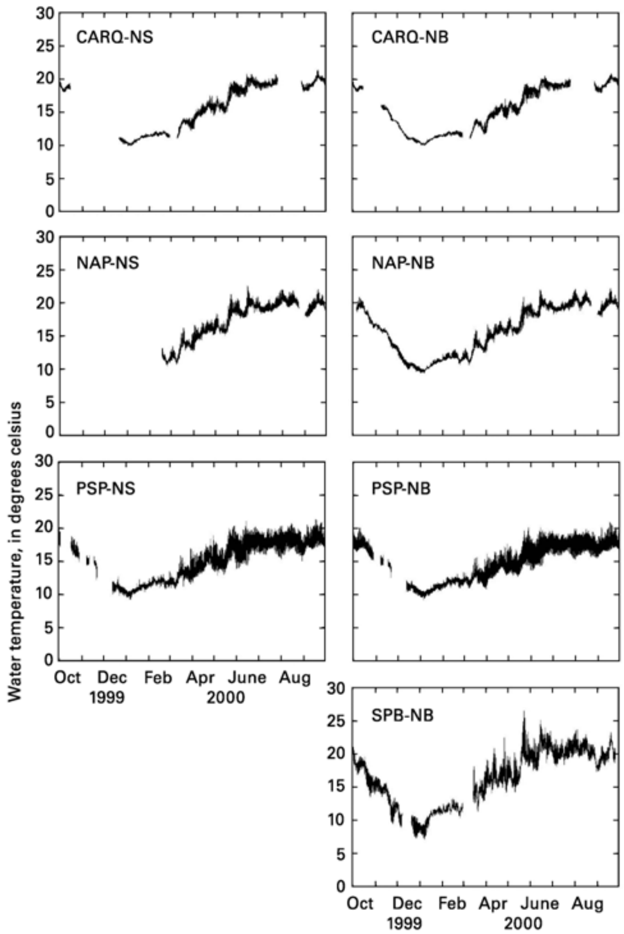

Figure 4 Near-surface (NS) and near-bottom (NB) measurements of water temperature at Carquinez Bridge (CARQ), Napa River (NAP), Point San Pablo (PSP) and San Pablo Bay (SPB), San Francisco Bay, water year 2000

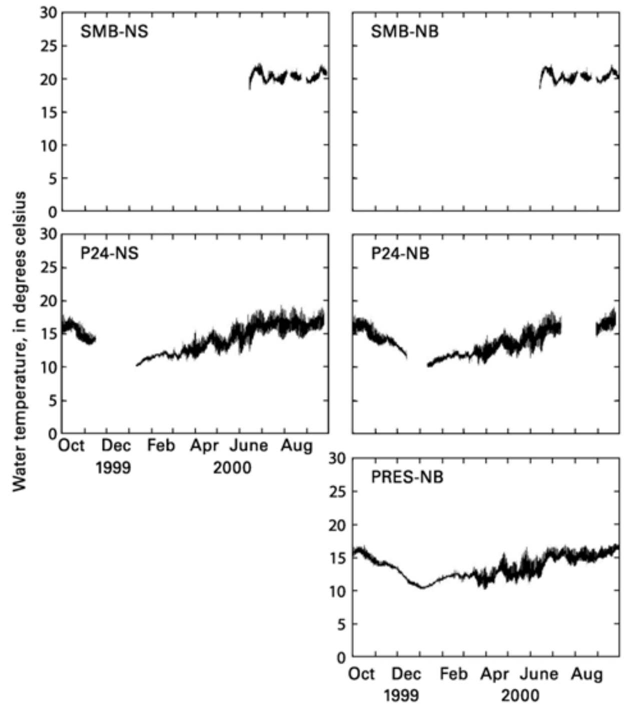

Figure 5 Near-surface (NS) and near-bottom (NB) measurements of water temperature at San Mateo Bridge (SMB), Pier 24 (P24), and Presidio (PRES), San Francisco Bay, water year 2000

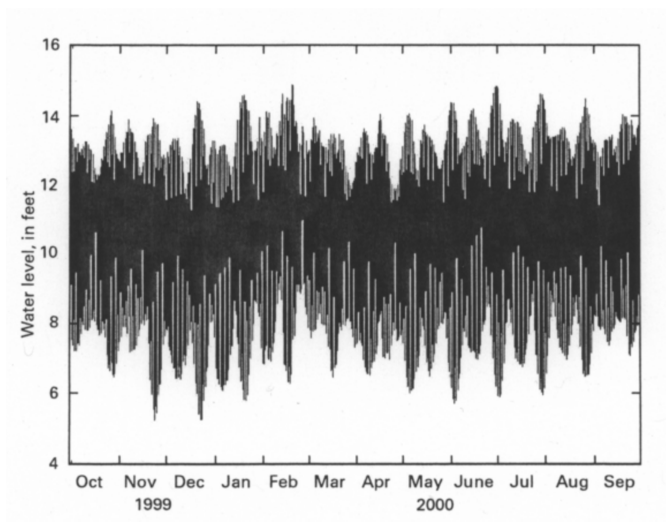

Figure 6 Water levels at Point San Pablo, San Francisco Bay, water year 2000. Vertical datum is 10 feet below mean sea level.

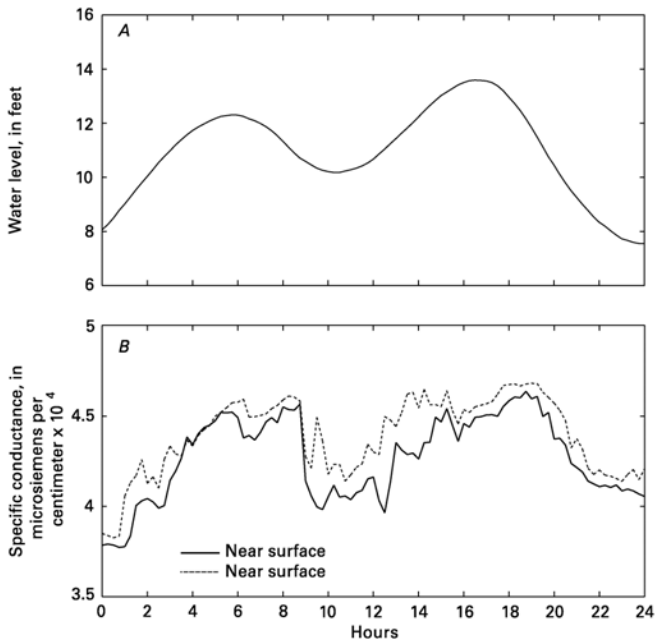

Figure 7 Near-surface and near-bottom measurements of (A) water levels and (B) specific conductance at Point San Pablo, San Francisco Bay, October 1, 1999. Vertical datum is 10 feet below mean sea level. For reference, seawater has a specific conductance of 53,000 microSiemens per centimeter (5.3×10^4)

Other data, including maximum and minimum values of specific-conductance, water-temperature, and water-level data for the seven sites, are published annually in volume 2 of the USGS California water data report series available on the USGS website (http://ca.water.usgs.gov).

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Fall Dissolved Oxygen Conditions in the Stockton Ship Channel for 2000

Casey Ralston and Stephen P. Hayes (DWR), cralston@water.ca.gov

Introduction

Dissolved oxygen concentrations in the Stockton Ship Channel typically drop below 5.0 mg/L during the late summer and early fall of each year, especially in the eastern portion of the channel. Low San Joaquin River inflows, warm water temperatures, high biochemical oxygen demand, reduced tidal circulation, and intermittent reverse flow conditions in the San Joaquin River past Stockton are all likely to contribute to the dissolved oxygen decrease in this area. Low dissolved oxygen concentrations can cause physiological stress to fish and hinder upstream migration of salmon.

To protect fish and the aquatic ecosystem, water quality objectives for dissolved oxygen have changed over the years in the Stockton Ship Channel. The Central Valley Regional Water Quality Control Board in the Basin Plan originally set a baseline standard of 5.0 mg/L for the entire Delta region (including the Stockton Ship Channel) throughout the year (CVRWQCB 1998). This objective was modified to 6.0 mg/L within the channel from Turner Cut to Stockton from September through November when the Bay-Delta Plan (SWRCB 1995) was adopted by the SWRCB on May 22, 1995. The 6.0 mg/L objective within the channel has now been included in Water Right Decision 1641 (D-1641), which superseded the Bay-Delta Plan when it was adopted by the SWRCB on December 29, 1999 (SWRCB 1999). Because the majority of the channel study area is within the designated 6.0 mg/L objective area (Figure 1) and the majority of the study occurs from September through November, we compared the data to the 6.0 mg/L objective.

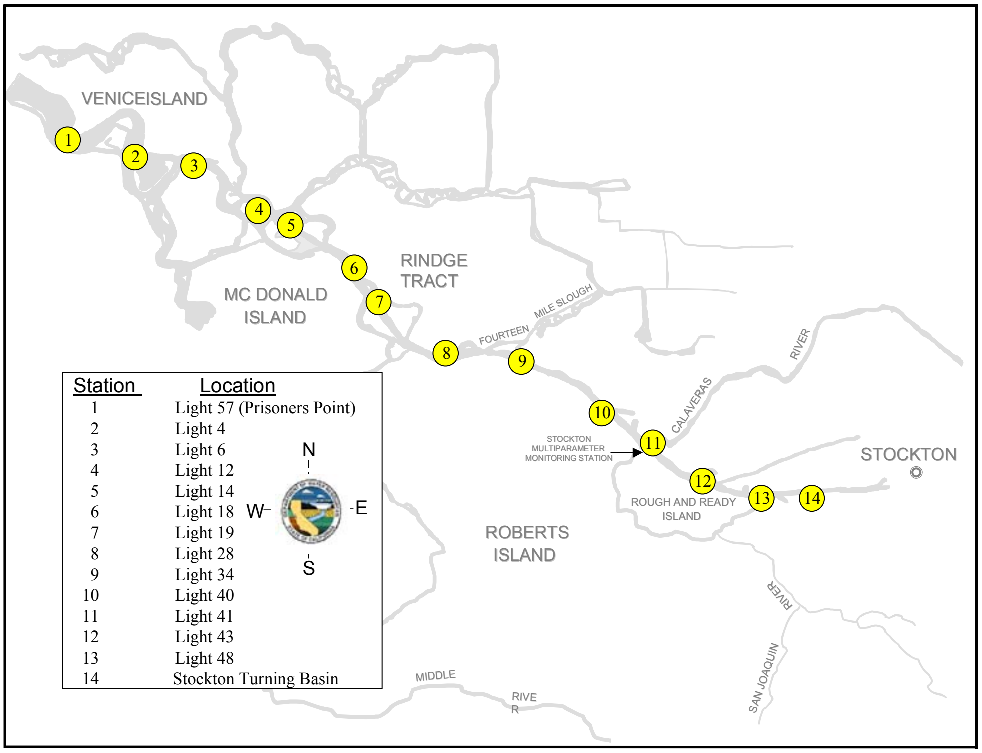

Figure 1 Monitoring sites in the Stockton Ship Channel

Since 1968, the Bay-Delta Monitoring Section and supporting Interagency Ecological Program (IEP) staff have measured dissolved oxygen concentrations in the channel during the late summer and early fall of each year. Dissolved oxygen is monitored to determine if placement of a temporary rock barrier across the head of Old River is necessary. This monitoring also documents dissolved oxygen levels during and after the placement of the barrier, if the barrier is affecting dissolved oxygen levels.

As part of a 1969 Memorandum of Understanding between the Department of Water Resources (DWR), the U.S. Fish and Wildlife Service, the U.S. Bureau of Reclamation, and the Department of Fish and Game, the Department of Water Resources usually installs the barrier during periods of projected low fall San Joaquin River outflow. The barrier increases net flows down the San Joaquin River past Stockton, which may contribute to the improvement of low dissolved oxygen concentrations in the eastern Stockton Ship Channel.

DWR installed the barrier at the head of Old River on October 7, 2000, because late summer San Joaquin River flows past Vernalis were relatively low (average daily San Joaquin River flows past Vernalis were approximately 2,300 cfs [64.1 m^3/s] in September), and fall flows were not projected to be sufficient to alleviate low dissolved oxygen conditions in the eastern channel. The barrier was removed on December 8, 2000, due to a sustained improvement in dissolved oxygen conditions throughout the channel, and in response to potential bank erosion and overtopping concerns resulting from an anticipated increase in late fall flows. These flows were projected to be sufficient to maintain acceptable dissolved oxygen levels throughout the channel. This report summarizes monitoring results for a year when the portion of San Joaquin River flow that normally enters Old River was diverted downriver toward the channel.

Methods

Monitoring of dissolved oxygen concentrations in the Stockton Ship Channel was conducted by vessel seven times between August 14, 2000, and November 14, 2000[1]. During each of the monitoring runs, 14 sites were sampled at low water slack tide from Prisoners Point in

1. Funding for these special studies was provided by the DWR Division of Operations and Maintenance.

the central Delta (Station 1) to the Stockton Turning Basin (Station 14) at the terminus of the channel (Figure 1). Dissolved oxygen and water temperature data were collected at each site near the surface and bottom of the water column during ebb slack tide using a Hydrolab Model DS-3 Multiparameter Surveyor, Seabird 9/11 multiparameter sensor or YSI 6600 Sonde[1].

Results

A dissolved oxygen sag (levels ≤5.0 mg/L) was rarely present within the channel throughout the late summer and fall of 2000. However, a persistent dissolved oxygen depression (levels ≤6.0 mg/L) occurred within the central portion of the channel throughout much of August and September of 2000 due in part to warm water conditions and relatively low San Joaquin River inflows.

Dissolved oxygen levels differ by regions within the channel. Dissolved oxygen concentrations within the western portion of the channel from Station 1 to Station 4 were relatively high and stable throughout the study period. Dissolved oxygen values ranged from 6.7 to 11.2 mg/L from August 14 to November 14 (Figure 2). The robustness of dissolved oxygen concentrations in this portion of the channel is apparently due to the greater tidal mixing and the absence of conditions creating excessive biochemical oxygen demand.

In the central portion of the channel from Station 5 to Station 9, dissolved oxygen concentrations dropped from the consistently high concentrations in the western channel to concentrations approaching 5.0 mg/L throughout the monitoring period (Figure 2). In the eastern channel from Station 10 to Station 13, the dissolved oxygen concentrations were stratified and more variable than those of the central channel, and ranged from 5.0 mg/L in August to 9.25 mg/L in November (Figure 2). The inflow of the San Joaquin River into the eastern channel partially accounts for the variable dissolved oxygen levels in this region.

A persistent dissolved oxygen depression developed at the surface and at the bottom of the central channel throughout August. On August 14, a surface depression developed from Station 6 through Station 9 in the central channel, and a more extensive bottom depression developed from Station 6 in the central channel through Station 12 in the eastern channel. In the heart of this region (Stations 7 through 9), bottom dissolved oxygen levels dropped to 5.0 mg/L or less.

In the eastern portion of the channel a significant dissolved oxygen stratification developed, with bottom dissolved oxygen levels approximately 2 to 3 mg/L less than surface levels. Dissolved oxygen conditions within the channel improved slightly on August 29, as the bottom dissolved oxygen sag within the central channel and the stratification within the eastern channel disappeared. However, a surface and bottom depression persisted primarily within the central channel. Relatively warm, late-summer water temperatures (22 to 27 °C) and low San Joaquin River inflows into the channel east of Rough and Ready Island appear to have contributed to the low dissolved oxygen concentrations in the central and eastern channel. Average daily flows in the San Joaquin River past Vernalis in August ranged from 1,638 cfs to 2,802 cfs (46.4 to 79.3 m^3/s). Reverse flow conditions were consistently present in the San Joaquin River past Stockton, as average daily flows ranged from –401 to +89 cfs (–11.4 to +2.5 m^3/s) in August.

Dissolved oxygen levels continued to improve in early September, but returned to depressed levels by the end of the month. On September 12, surface and bottom dissolved oxygen levels at all stations were 6.8 mg/L or greater. However, stratified dissolved oxygen conditions returned to Stations 10 through 13 in the eastern channel. On September 26, a dissolved oxygen depression returned to the central channel, with surface values at Stations 6 and 7, and bottom values at Stations 6 through 9 ranging from 5.0 to 5.8 mg/L. The minimum surface and bottom dissolved oxygen values of 5.0 mg/L were measured at Station 7 in the heart of this region. Although September water temperatures (21 to 24 °C) were slightly cooler than August temperatures within the channel, September flows in the San Joaquin River were similar to those of August. Average daily flows past Vernalis ranged from 2,022 to 2,930 cfs (57.3 to 83.0 m^3/s). Intermittent reverse flow conditions past Stockton persisted in September as average daily flows ranged from –244 to +170 cfs (–6.9 to 4.8 m^3/s).

1. Monitoring of the channel by vessel is supplemented by information from an automated multi-parameter water quality recording station near Stockton at the western end of Rough and Ready Island.

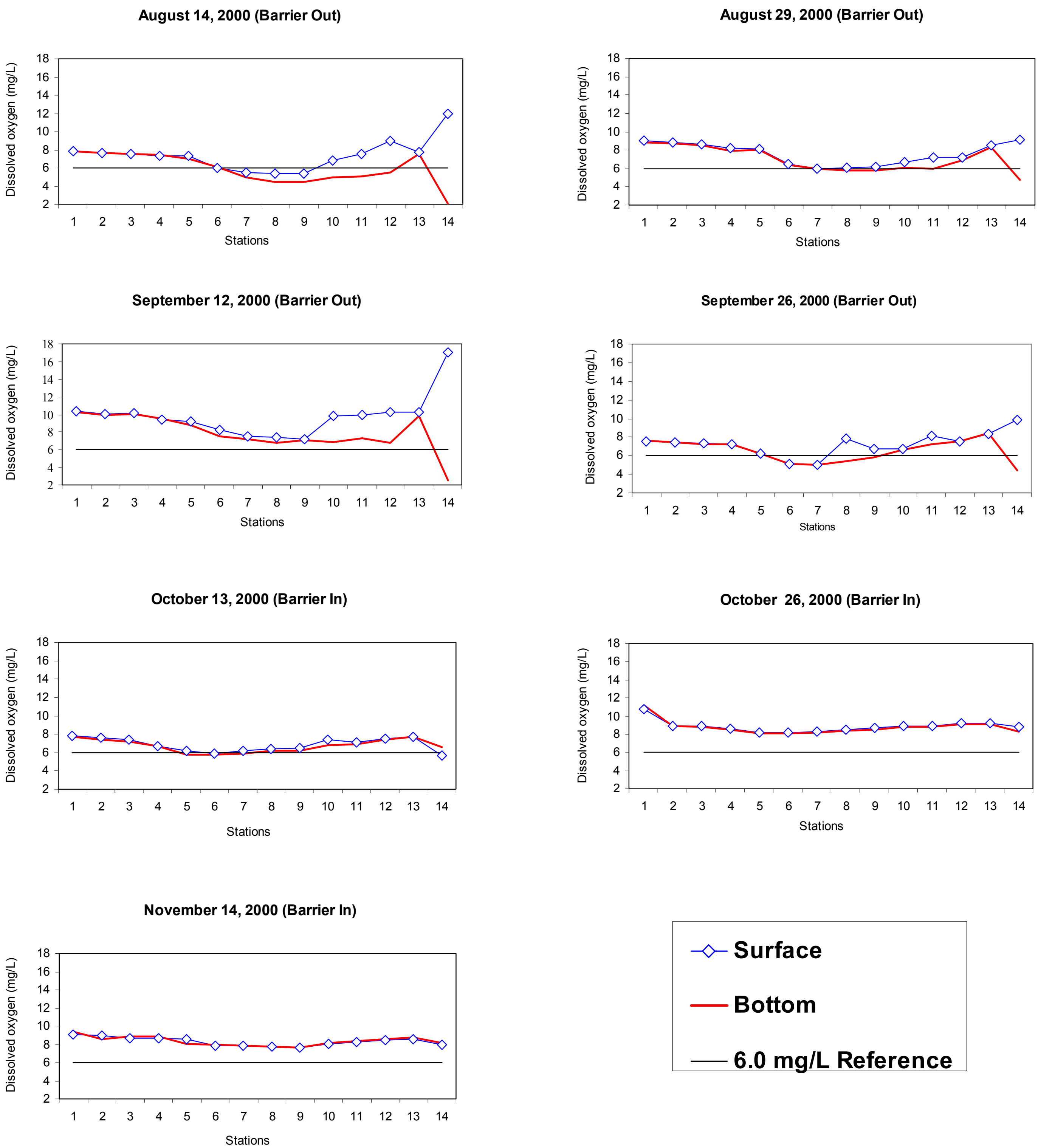

Figure 2 Dissolved oxygen concentrations in the Stockton Ship Channel in 2000

A gradual but sustained improvement of dissolved oxygen conditions within the channel occurred in October. Initial sampling on October 13 showed a minor depression within the center of the channel, with bottom levels between 5.8 to 5.9 mg/L at Stations 5 through 7, and a surface measurement of 5.9 mg/L at Station 5. By October 26, conditions throughout the channel had recovered substantially. Dissolved oxygen concentrations throughout the channel were greater than 8.0 mg/L. These higher values can be attributed to cooler water temperatures (14 to 19 °C) and locally improved inflow conditions. Average daily river flows past Vernalis ranged from 2,223 to 3,658 cfs (62.9 to 103.6 m^3/s) in October, and intermittent reverse flow conditions past Stockton were eliminated through much of October. Average daily flows in the San Joaquin River past Stockton in October ranged from –146 to +626 cfs (–4.1 to 17.7 m^3/s).

Monitoring on November 14 confirmed a sustained improvement of dissolved oxygen levels throughout the channel. Surface dissolved oxygen levels ranged from 7.6 to 9.1 mg/L and bottom levels ranged from 7.6 to 9.4 mg/L. Water temperatures, at 12 to 16 °C, were 2 to 3 °C cooler than temperatures recorded on October 26. The relatively high San Joaquin River flows past Vernalis were maintained in November, as average daily flows past Vernalis ranged from 2,227 to 2.932 cfs (63.1 to 83.0 m^3/s). In addition, average daily flows past Stockton ranged from –225 to 292 cfs (–6.4 to 8.3 m^3/s). Cooler water temperatures, increased San Joaquin River inflows, reservoir releases, and increased rainfall apparently contributed to and maintained the improved dissolved oxygen concentrations throughout the channel. Because of the sustained improvement, no further dissolved oxygen studies were conducted.

Highly stratified dissolved oxygen conditions were detected in the Stockton Turning Basin (Station 14) throughout much of the late summer of 2000. Sampling on August 14 and 29 and September 12 and 26 showed surface dissolved oxygen concentrations ranging from 9.1 to 17.0 mg/L, and bottom dissolved oxygen concentrations ranging from 2.1 to 4.8 mg/L. Sampling on October 13 and 26, and November 14, showed that the distinct dissolved oxygen stratification had subsided, with surface dissolved oxygen concentrations ranging from 5.7 to 8.9 mg/L and bottom dissolved oxygen concentrations ranging from 6.6 to 8.3 mg/L.

The periodic dissolved oxygen stratification appears to be the result of localized biological and water quality conditions occurring in the Turning Basin. The basin is at the eastern dead-end terminus of the channel and is subject to reduced tidal activity, restricted water circulation, and increased residence times when compared to the remainder of the channel. As a result, water quality and biological conditions within the basin have historically differed from those within the main downstream channel, and have led to extensive late summer and fall algal blooms and die-offs. The late summer and early fall of 2000 were no exception, as an intense algal bloom composed of cryptomonads, diatoms, flagellates, and blue-green and green algae was detected. Stratified dissolved oxygen conditions appear to be produced in the water column of the basin by blooms in the following manner: (1) high algal productivity at the surface of the basin produces elevated surface dissolved oxygen concentrations; and, (2) dead or dying bloom algae settle out of the water column and sink to the bottom to contribute to high biochemical oxygen demand (BOD). Bottom dissolved oxygen concentrations in the basin are further degraded by additional BOD loadings in the area, such as regulated discharges into the San Joaquin River and from recreational boating activities adjacent to the basin. When bloom activity subsides, the dissolved oxygen stratification is reduced, and basin surface and bottom dissolved oxygen concentrations become less diverse.

Conclusions

Dissolved oxygen concentrations in the central and eastern Stockton Ship Channel consistently fell below 6.0 mg/L in the late summer and early fall of 2000 due in part to relatively low flows in the San Joaquin River past Vernalis and warm water temperatures in August and September. As a result of low dissolved oxygen levels, a temporary barrier was installed at the head of Old River to increase flows down the main channel of the San Joaquin River. On October 7, 2000, dissolved oxygen levels improved to greater than 7.0 mg/L throughout the channel. Dissolved oxygen conditions improved at least partly in response to cooler water temperatures, increased San Joaquin River inflows, and the reduction of reverse flow conditions past Stockton due to the placement of the barrier, reservoir releases, and increasing rainfall. The barrier was removed on December 8, 2000.

References

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(Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region, Sacramento River Basin and San Joaquin River Basin. 4th ed. Sacramento, CA. 80 p.

[SWRCB] State Water Resources Control Board. 1995. Water Quality Control Plan for the San Francisco Bay/ Sacramento-San Joaquin Estuary. Sacramento, CA. 45 p.

[SWRCB] State Water Resources Control Board. 1999. Water Right Decision 1641 to implement flow objectives for the Bay-Delta Estuary, approve a petition to change points of diversion of the CVP and SWP in the southern Delta, and approve a petition to change places of use and purposes of use of the CVP. Sacramento, CA. 211 p.

On the Horizon

An Update on the Early Life History of Fishes in the San Francisco Estuary and Watershed Symposium and Proceedings

Fred Feyrer (DWR), ffeyrer@water.ca.gov; Larry Brown (USGS); Jim Orsi (DFG, retired), Randy Brown (DWR, retired); and Mike Chotkowski (USBR)

This exciting project is going full steam ahead and will be funded primarily by IEP, with some additional support from the CALFED Science Program. The symposium will take place in early 2003 and will be held in California at a conference associated with the American Fisheries Society. In an effort to inform others of the content being developed for this symposium and proceedings volume (and to put the force of peer pressure on our esteemed colleagues to complete their manuscripts on time), below is the most recent list of contributed papers and topics. Additional papers from anyone interested in publishing work on the science or management of fish early life history in the estuary, adjacent coastal ocean, or watershed are highly encouraged. Participation at the symposium for all presenters will be paid for by IEP. Contact Fred Feyrer (ffeyrer@water.ca.gov) if you are interested in participating.

- Larval fish assemblages of San Francisco Bay
  M. McGowan (SFSU)
- Ecology of larval herring (*Clupea harengus*) in San Francisco Bay
  S. Bollens and A. Sanders (RTC/SFSU)
- The importance of salinity to larval Pacific herring in San Francisco Bay
  F. Griffin (UCD/BML)
- Larval anchovy ecology in San Francisco Bay
  M. McGowan (SFSU)
- Characteristics of atherinid spawning and rearing habitat in east-central San Francisco Bay
  A. Jahn, J. Amdur, and J. Zaitlin (Port of Oakland)
- Larval fish ecology in Suisun Marsh
  R. Schroeter and P. Moyle (UCD)
- Fish abundance and distribution trends from DFG's 20-mm Survey
  M. Dege and K. Fleming (DFG)
- Spatial and temporal trends in larval fish abundance in the Sacramento-San Joaquin Delta
  L. Grimaldo (DWR)
- Ecological segregation of native and non-native larval fish communities in the southern Sacramento-San Joaquin Delta
  F. Feyrer (DWR)
- Cohort mortality of larval striped bass in the San Francisco Estuary, California
  S. Foss and L. Miller (DFG)
- Vertical distribution of delta smelt in the San Francisco Estuary, California
  A. Rockriver and K. Fleming (DFG)
- Egg and larval dispersion in a tidal channel with diversions using a particle tracking model
  C. Harrison and C. Enright (DWR)
- Tidal and diel variability in fish entrainment through screened and unscreened agricultural diversion siphons in the lower Sacramento River
  M. Nobriga and Z. Matica (DWR)
- Feeding ecology of larval fishes in the entrapment zone of the San Francisco Estuary, California
  B. Bennett and J. Hobbs (UCD/BML)

- Feeding ecology of larval striped bass
  L. Miller and J. Arnold (DFG)
- Feeding ecology of juvenile striped bass
  J. Arnold and L. Miller (DFG)
- Feeding ecology of larval splittail
  R. Kurth and M. Nobriga (DWR)
- Ecological patterns in larval fish communities of the upper Sacramento River
  M. Marchetti (CSU Chico)
- Larval fish ecology in Central Valley streams
  A. Rockriver (CSU Sacramento/DFG)
- Spawning by native and alien fish on a restored floodplain: evidence from larvae
  P. Crain and P. Moyle (UCD)
- Comparison of larval fish communities in the Yolo Bypass and Sacramento River
  T. Sommer and B. Harrell (DWR)
- The hyporheic environment of larval salmonids in several Central Valley streams
  J.G. Williams, T. Horner, K. Vyverberg, and J. Merz
- Estimating growth rates of young Central Valley chinook salmon using otolith microstructures
  Rob Titus (DFG)
- Factors influencing the feeding behavior of delta smelt (*Hypomesus transpacificus*)
  J. Lindberg and B. Bridges (UCD)
- Embryogenesis and larval development of delta smelt
  R. Mager (UCD/DWR)
- Toxicity and teratogenicity of contaminants in embryos and larvae of special status delta fishes
  S. Teh (UCD)

Bay-Delta Science Consortium—An Update

Randy Brown (DWR, retired), rl_brown@pacbell.net

In December the Bay-Delta Science Consortium reached a milestone of sorts—all 13 agencies and organizations submitted their signed copies of the Memorandum of Understanding to the Advisory Committee. The signatories include most of the IEP member agencies as well as several local universities and non-profit organizations. The Advisory Committee will now be considering additional members.

The Advisory Committee has continued to meet at approximately six-week intervals and is considering a the following items of possible interest to the Bay-Delta community.

- Although we continue to work on a mission statement, the overall goal is to enhance cooperation and collaboration among researchers working in the Bay-Delta. We hope to have a final mission statement in the next few weeks.
- CALFED intends to allocate one million dollars per year for the next few years to the Consortium to help sponsor activities that will help increase collaboration and cooperation. Zach Hymanson has led development of procedures for soliciting and reviewing proposals to be funded through the Consortium. In general the procedures will be similar to those used by CALFED in its Directed Action Proposal Solicitation Process. Once the procedures are agreed upon, and we are getting close, we will begin the formal solicitation process.
- The Consortium will be sponsoring an online technical journal. We have been working on a prospectus for the journal and CALFED is recruiting co-editors-in-chief through the Association of Bay Area Governments. The goal is to have one or more issues of the journal online by this fall. Some of the CALFED white papers and articles from the CALFED-funded Breach Study and articles from UC Davis studies on the Cosumnes River are likely candidates for early publication. We will make additional details available as the prospectus and guide to authors become final.

- The IEP and USGS continue to pursue moving some staff to proposed facilities at Rio Vista and on or near the UC Davis campus. UC Davis will soon announce selection of a contractor to build facilities in their Enterprise Zone, just south of the main campus. State and federal agencies will be negotiating with the selected builder and UC Davis to determine if a lease structure can be developed to allow agency staff to occupy a portion of the projected facilities. Site plans are progressing fairly well at Rio Vista, but financing and lease structure are still to be determined.
- Database and website managers from Consortium members have begun a series of meetings to investigate ways of sharing digital information among the many data holders and increasing its utility for synthetic analyses. Workshops to date have recommended a highly distributed information system, with primary copies of data being held by their originators, but shared through symmetrical replication (regular exchange with a data clearinghouse), or through open-source "semantic web" technologies using XML and related technologies, or both. Effective sharing requires that cooperators adopt agreed-upon vocabularies or "thesauri" (examples include keywords species names, place names, and standard methods). Workshops will be scheduled in the early spring to address both content issues, such as keywords, and business practices, such as database platforms and security.
- The Advisory Committee is considering hiring a consultant to work with over the next several months. The consultant would serve as sort of an interim Executive Director, with the principal responsibility of getting the Consortium off the ground.

If you would like more information about the Bay-Delta Science Consortium please contact me, Perry Herrgesell (pherrges@delta.dfg.ca.gov) or Barbara McDonnell (bmcdonne@water.ca.gov).

CALFED Science Conference 2003 Save the Date!

Fred Nichols (fnichols@pacbell,net) and Randy Brown (rl_brown@pacbell.net)

The next CALFED Science Conference will be held January 14–16, 2003, at the Sacramento Convention Center. Fred Nichols and Randy Brown are again serving as conference co-chairs, Elise Holland and Larry Brown are co-program chairs, and Anke Mueller-Solger and Bruce Thompson will be organizing a poster session. Marcia Brockbank and Joan Patton, representing the San Francisco Estuary Project and the Association of Bay Area Governments, will once again be handling many of the administrative details, including making sure attendees get plenty to eat and drink. We have assembled a 20-person advisory committee to help conference planning.

Although a theme has not yet been selected, it will have something to do with restoration of ecological functions and resources and an assessment of how well CALFED-funded and other projects are helping to achieve restoration goals. We will likely be organizing a second poster session to include updates and results from restoration projects funded by CALFED and other programs. The conference will consist of a plenary session, concurrent technical sessions, and probably two poster sessions. The posters will probably be displayed during the entire conference and we are planning two hosted receptions, during which attendees can view the posters and meet the authors.

We met with the program chairs and advisory committee in early December and will meet again on February 8. We agreed on the following tentative schedule:

- Formal save-the-date flyer sent in early March.
- Request for abstracts sent in May
- Abstracts due in mid-September

The Science Conference was originally scheduled to be held in October 2002, but the Convention Center was already booked for most of the fall. We will be booking facilities for the fall of 2004 for the third Science Conference. We will also be working with representatives of the San Francisco Estuary Project, the Interagency Ecological Program, and the Bay-Delta Modeling Forum to coordinate their respective conferences and workshops to help ensure that they fill unique niches and needs.

If you have suggestions about the conference, in particular regarding technical sessions you would like to see included, please contact Fred or Randy at the above e-mail addresses.

Reliable and Timely Distribution of the *IEP Newsletter*

Lauren Buffaloe, DWR
buffaloe@water.ca.gov

Print production of the IEP Newsletter will be slowed somewhat due to new procedures within state government. No cause for concern, however—you will still be able to read and download newsletter issues via the website. If you are interested in receiving an e-mail notice when the Adobe PDF version is posted to the website, please contact me at buffaloe@water.ca.gov or 916 227-1375. It is my sincere desire to continue to provide to you timely information about scientific research within the Bay-Delta Estuary.

ERRATA

In the last issue of the *IEP Newsletter*, a footnote was omitted from the article "Influence of Salinity, Bottom Topography, and Tides on Locations of Estuarine Turbidity Maxima in Northern San Francisco Bay," by D.H. Schoelhammer. The footnote text is given below and should have referenced the title of the article.

"This article is reprinted from Schoellhamer, D.H., 2001, Influence of salinity, bottom topography, and tides on locations of estuarine turbidity maxima in northern San Francisco Bay. *In*: McAnally, W.H., Mehta, A.J., ed., Coastal and estuarine fine sediment transport processes. Elsevier Science: B.V., p. 343–357, URL: http://ca.water.usps.gov/abstract/sfbay/elsevier0102.pdf.

"The contributions in this volume are based on submissions following the 5th International Conference on Nearshore and Estuarine Cohesive Sediment Processes (INTERCOH 1998) held in Seoul, Korea."

DELTA WATER PROJECT OPERATIONS

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From October through December 2001, San Joaquin River flow ranged from 1,300 to 5,000 cfs (37 to 140 m^3/s); Sacramento River flow ranged between 7,000 to 36,000 cfs (200 to 1,025 m^3/s); and the Net Delta Outflow Index (NDOI) ranged between 2,000 to 38,000 cfs (59 to 1,100 m^3/s) (Figure 1). Precipitation from storm events in mid-November and early December in the Sacramento River watershed resulted in increased Sacramento and NDOI flows. These storms did not increase flows in the San Joaquin River.

Project pumping was low throughout October to meet outflow standards (Figure 2). Increased pumping resumed in November. Water quality concerns at the Contra Costa Canal pumps caused the water projects to briefly reduce exports in early December. The mid-December increase in State Water Project exports resulted in lower NDOI (Figures 1 and 2).

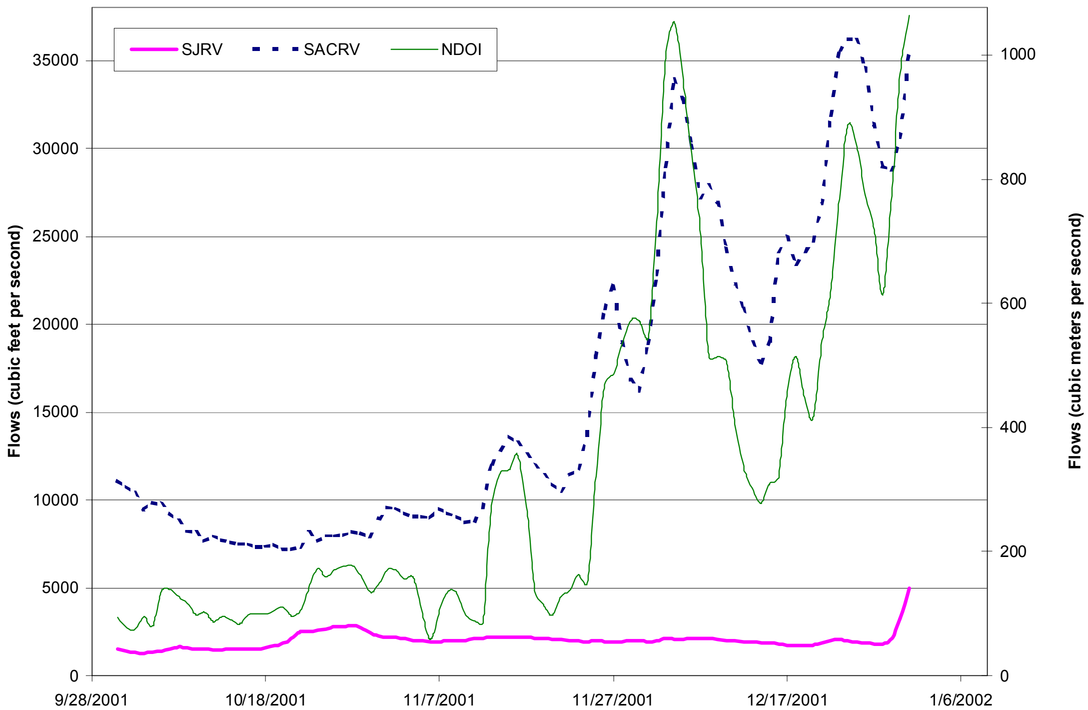

Figure 1 Sacramento and San Joaquin river flows and NDOI, October–December 2001

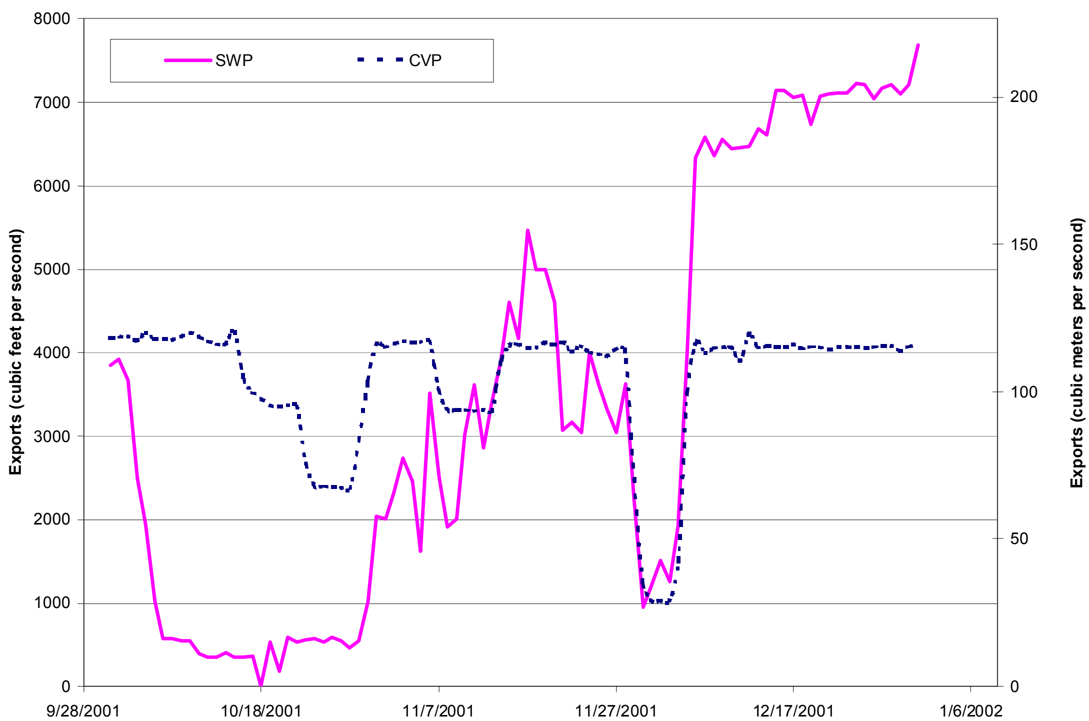

Figure 2 State Water Project (SWP) and Central Valley Project (CVP) pumping, October–December 2001

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For information about the Interagency Ecological Program, visit our website on-line at http://www.iep.water.ca.gov. Readers are encouraged to submit brief articles or ideas for articles. All correspondence, including submissions for publication, requests for copies, and mailing list changes should be addressed to Lauren Buffaloe, California Department of Water Resources, 3251 S Street, Sacramento, CA, 95816-7017.

IEP NEWSLETTER

Interagency Ecological Program for the San Francisco Estuary

The Interagency Ecological Program for the San Francisco Estuary
is a cooperative program of the

California Department of Water Resources
State Water Resources Control Board
US Bureau of Reclamation
US Army Corps of Engineers
California Department of Fish and Game
US Fish and Wildlife Service
US Geological Survey
US Environmental Protection Agency

National Marine Fisheries Service

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